911

THE RUBBER RESEARCH INSTITUTE OF MALAYA

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23 SEPT. 1935
INSTITUTE

ANNUAL REPORT 1934

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THE RUBBER RESEARCH INSTITUTE of MALAYA

Members of the Board

JULY, 1935

The Director of the Institute (Lieut. Col. B. J. Eaton, o.b.e.)	Chairman, *ex officio*
The Hon'ble the Financial Adviser, F.M.S.	Financial Member appointed by the High Commissioner under section 5 (i) (b) of Enactment no. 14 of 1934
The Hon'ble the Director of Agriculture, S.S. and Adviser on Agriculture, Malay States	*Ex officio*
Che Hamzah bin Abdullah, m.c.s. Orang Kaya Kaya Stia Bijaya di-Raja, Perak (Che Mohamed Noordin bin Abdul Shukor, i.s.o.)	appointed by the High Commissioner under section 5 (i) (d) of Enactment no. 14 of 1934
Mr. A. P. Cranna Mr. Choo Kia Peng, c.b.e., j.p. Mr. J. S. Ferguson, j.p. The Hon'ble Mr. B. J. R. Barton Mr. J. C. Innes, j.p.—on leave (The Hon'ble Mr. J. Robertson—acting)	appointed by the High Commissioner under section 5 (i) (e) of Enactment no. 14 of 1934

The Permanent Committee

The Director of the Institute	Chairman, *ex officio*
The Hon'ble the Financial Adviser, F.M.S.	Financial Member, *ex officio*
Mr. A. P. Cranna Mr. Choo Kia Peng, c.b.e., j.p. Mr. J. C. Innes, j.p.—on leave (The Hon'ble Mr. J. Robertson—acting)	appointed by the High Commissioner under section 13 (i) (c) of Enactment no. 14 of 1934

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PUBLICATIONS

Publications of the Rubber Research Institute are issued in the following forms :—

(a) Planting Manuals appearing at irregular intervals at a price to be fixed for each number

(b) Bulletins appearing occasionally at a price to be fixed for each number

(c) Journal R.R.I. appearing at irregular intervals each year

(d) Annual Reports

(e) Information Cards

The following publications have been issued and copies can be obtained on application at the prices given against each :—

(a) Planting Manuals

No. 1, "Preparation of Plantation Rubber" by B. J. Eaton	...	$2.00
No. 2, "Budding of Hevea in Modern Plantation Practice" by F. Summers	...	$2.00
No. 3, "Plantation Sheet Rubber Manufacture" by R. O. Bishop	...	$2.00
No. 4, "Latex Preservation and Shipment" by R. O. Bishop and R. G. Fullerton	...	$2.00
No. 5, "The History and Description of Clones of Hevea Brasiliensis" by C. E. T. Mann and C. C. T. Sharp		
Illustrated by H. C. Chuan	...	$2.00
Stiff cover for filing the leaflets	...	$1.00
No. 6, "The Uses and Control of Natural Undergrowth on Rubber Estates" by W. B. Haines	...	$1.00
Stiff cover for filing the leaflets	...	$0.50

(b) Bulletins

No. 1, "Natural Coagulation of Hevea Latex" by A. S. Corbet	...	$1.00
No. 2, "A Study of the Effect of Damp Storage on Raw Rubber" by B. J. Eaton and R. G. Fullerton	...	$1.00
No. 3, "The Root Disease Problem on Old Rubber Areas in Malaya" by A. Sharples and A. R. Sanderson	...	$1.00
No. 4, "Summary of Meteorological Records, Soils Division" by W. B. Haines	...	$1.00
No. 5, "Variations in the Composition of Latex from Clone and Seedling Rubber" by J. L. Wiltshire	...	$1.00

(c) Journal of the R.R.I.

Vol. 1 Nos. 1, 2—two numbers combined	...	$1.00
Vol. 1 „ 3, 4 Vol. 2 „ 1, 2, 3, 4 Vol. 3 „ 1, 2, 3 Vol. 4 „ 1, 2 Vol. 5 „ 1, 2, 3, 4 — each number	...	$0.50

(d) Annual Reports

from 1928 — each	...	$1.00

(e) Information Cards

dealing with various Phases of Rubber Estate Factory Practice and Defects in Raw Rubber

in Malaya	...	$0.50
outside Malaya	...	$1.00

Bank commission should be added to outstation cheques.

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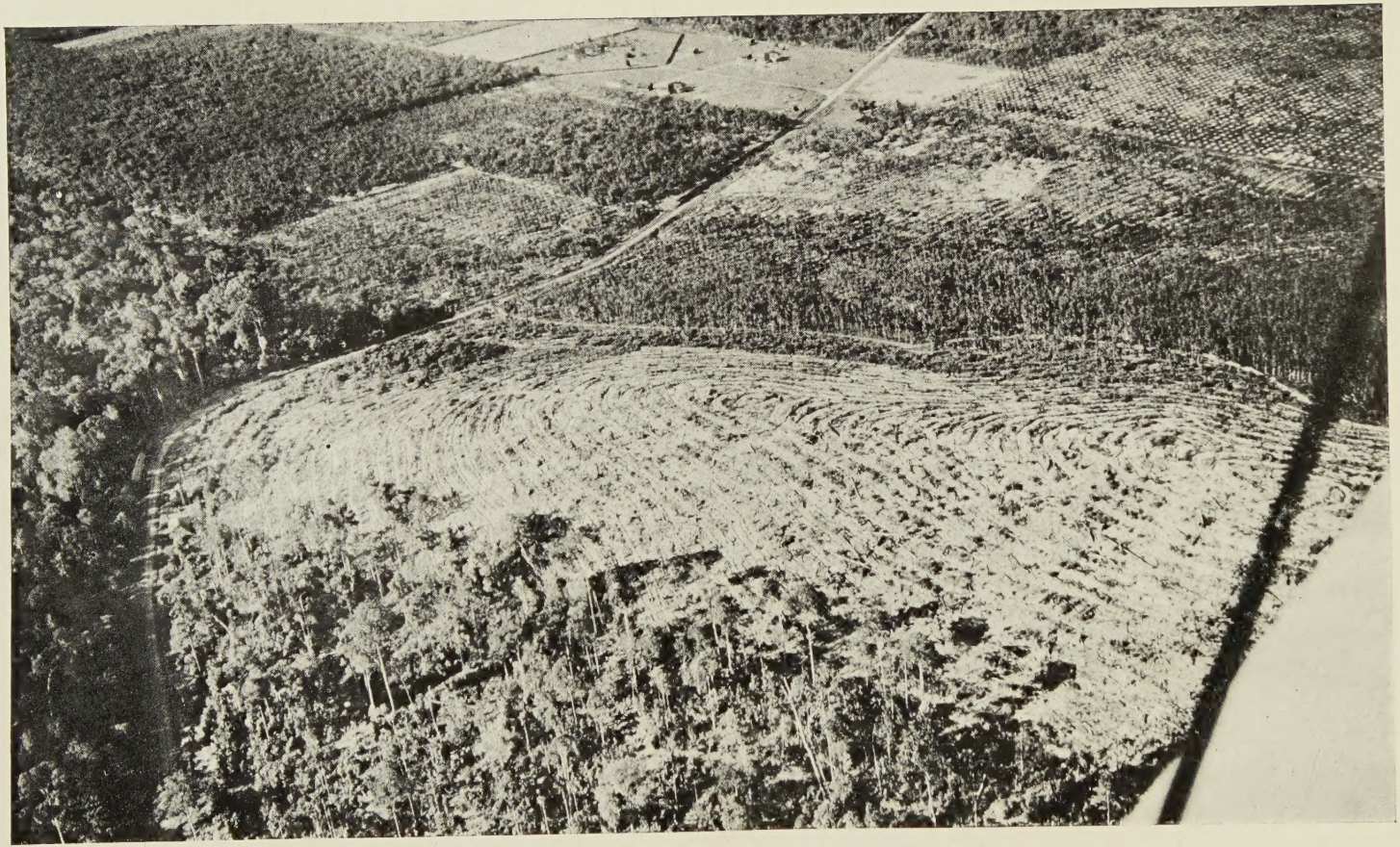

R.R.I. Experiment Station, Sungei Buloh, Selangor

(Aerial View)

REPORT OF THE BOARD

FOR THE YEAR ENDED 31st DECEMBER, 1934

Re-constitution of the Institute

The Commission of Enquiry appointed in 1933 by the High Commissioner for the Malay States, at the request of the Planters' Association of Malaya, the Malayan Estate Owners' Association and the Rubber Growers' Association "to make a full enquiry into the constitution, administration and working of the Rubber Research Institute and to indicate any changes that may be desirable (a) in the constitution or governance and (b) in the orientation of the research work of the Institute," made its report on the 7th July, 1933, and the Report was adopted by the Federal Council on the 30th October, 1933.

The more important of the Commission's recommendations were briefly:

1. That the constitution at that time existing be abolished and that the executive authority of the Institute be the Director, subject to

   (a) control in certain matters by a Board,

   (b) supervision in certain matters by a Permanent Committee,

   (c) advice from the London Advisory Committee.

2. That the constitution of the Board be

   (a) Chairman—the Director of the Institute,

   (b) a financial officer (to be styled "the Financial Member") nominated by the High Commissioner for the Malay States,

   (c) the Director of Agriculture, *ex officio*,

   (d) two members nominated by the High Commissioner to represent the interests of small-holders,

   (e) five members to be nominated by the High Commissioner from a panel of twelve persons recommended by the Planters' Association of Malaya, the Malayan Estate Owners' Association, and the Rubber Growers' Association jointly.

3. That the Permanent Committee shall consist of

(a) a Chairman—the Director

(b) a Vice-Chairman—the Financial Member

(c) three other members of the Board appointed by the High Commissioner, of whom not less than two shall be unofficials.

4. That the London Advisory Committee should

(a) advise the High Commissioner concerning the appointment of the Director of the Institute

(b) make and send to the Director observations on the programmes of research of the Institute and the financial proposals connected with them

(c) carry out such duties as it may agree upon with the Permanent Committee.

5. That the Director of the Institute be appointed by the High Commissioner for the Malay States upon the advice of the London Advisory Committee, and the members of the staff be appointed by the Permanent Committee on the advice of the Director.

6. That the Technological and Advisory Division be abolished, and that the Chemical Division be restored on its former basis.

7. That the suitability of the research and trial work on rubber roadways be discussed with the London Advisory Committee as soon as possible.

8. That special and adequate advisory service be provided for small-holder rubber growers.

The recommendations of the Commission were embodied in an Enactment which was passed at a meeting of the Federal Council on the 19th March, 1934, and became "The Rubber Research Institute of Malaya Enactment, 1934", No. 14 of 1934. The Enactment, which was published in the F.M.S. *Government Gazette* and came into force on the 15th June, 1934, provides for a constitution as stated above.

The Board under the Old Constitution

The personnel of the Board as at the 31st December, 1933, (vide *Annual Report, 1933*, pages 1—2) remained the same until

the 14th June, 1934, (except that Mr. J. S. Ferguson replaced Mr. W. A. Stanton as the representative of the Malayan Estate Owners' Association and the Hon'ble Mr. Rex resumed his seat as Treasurer, F.M.S.), after which date the new constitution took effect.

THE BOARD AND COMMITTEES UNDER THE NEW CONSTITUTION

On the 15th June, 1934, the following were appointed members of the Board:

Lt. Col. B. J. Eaton, O.B.E.,
(Director of the Institute), Chairman, *ex officio*;

The Financial Adviser, F.M.S.,
(The Hon'ble Mr. L. Rayman, M.C.S.), Financial Member, appointed by the High Commissioner;

The Director of Agriculture, S.S. & F.M.S.,
(The Hon'ble Dr. H. A. Tempany, C.B.E.), *ex officio*;

Che Hamzah bin Abdullah, M.C.S.
Orang Kaya Kaya Stia Bijaya di-Raja, Perak
(Che Mohamed Noordin bin Abdul Shukor)
} appointed by the High Commissioner to represent the interests of small-holders

Mr. A. P. Cranna
Mr. J. C. Innes, J.P.
Mr. Choo Kia Peng, C.B.E.
Mr. J. S. Ferguson
The Hon'ble Mr. B. J. R. Barton
} appointed by the High Commissioner from a panel nominated by Planting Associations.

The following members of the Board were on the same date appointed by the High Commissioner to be members of the Permanent Committee:

Mr. A. P. Cranna

Mr. J. C. Innes, J.P.

Mr. Choo Kia Peng, C.B.E.

The Director of the Institute and the Financial Member are *ex officio* members of the Committee.

The Rubber Roadways Committee, as formerly constituted, was re-appointed by the Board, and the question of its further

activities is now under discussion with the London Advisory Committee.

Board and Committee Meetings

During the year Board and Committee meetings as under were held:—

	Under the old Constitution	Under the new Constitution
Board—ordinary meetings ...	2	2
Board—special meetings ...	1	—
Executive & Finance Committee	3	—
Permanent Committee ...	—	2
Research Committee ...	—	—
Rubber Roadways Committee ...	2	—
Ad hoc Committees ...	—	2
	8	6

Revenue of the Institute

At the 1st January, 1934, the bases of contributions to the income of the Institute were

(a) a cess of 7 cents per pikul of rubber exported from the Federated Malay States and the States of Kedah, Kelantan and Trengganu;

(b) a contribution by the Straits Settlements Government at the rate of 7 cents per pikul of rubber calculated to have been produced in and exported from the Colony during the year 1933;

(c) a contribution by the Johore Government at the rate of $50,000 per annum.

These bases remained in operation until the 1st June, 1934, when, upon the coming into force in all territories of Malaya of enactments for the regulation of rubber production and export, it was prescribed that the expenditure of the Institute shall be met by contributions from Rubber Funds established under the Rubber Regulation Ordinance and Enactments.

The contributions received by the Institute for the year 1934 are:—

	In respect of the period Jan./May (old basis)	June/Dec. (new basis)	Total	Percentage of the total
	$ c.	$ c.	$ c.	
From the F. M. S. ...	158,327.72	108,410.69	266,738.41	63.19
„ Kedah ...	29,628.20	19,726.28	49,354.48	11.69
„ Kelantan ...	7,408.82	4,781.62	12,190.44	2.89
„ Trengganu ...			3,636.86	0.86
„ the S. S. ...	21,071.70	19,141.57	40,213.27	9.53
„ Johore ...			50,000.00	11.84
			$422,133.46	

The following table shows the quantity of rubber in tons estimated to have been produced in and exported from the Straits Settlements, the Federated Malay States and the Unfederated Malay States, for each year from 1929 to 1934.

	F. M. S.	Kedah	Kelantan.	Trengganu	Johore	Straits Settlements	Perlis	Total
1929	261,353	39,298	8,042	2,212	89,296	50,061	291	450,553
1930	250,122	38,303	7,375	1,998	90,639	45,929*	266	434,632
1931	244,149	40,290	6,593	1,860	90,778	30,198*	196	414,064
1932	235,892	39,044	5,171	1,817	86,686	36,936*	159	405,705
1933	250,550	47,121	9,290	2,456	96,941	43,261*	323	449,942
1934	269,867	52,254	11,573	4,002	103,528	46,201	516	487,941
Percentage of the total in 1934	55.3	10.7	2.4	0.8	21.2	9.5	0.1	

* amended.

Accounts for the Year 1934

Subjoined are the Income and Expenditure Account for the year 1934 and the Balance Sheet as at the 31st December 1934.

From the former it will be seen that the income from cess is $422,133.46 for the year 1934, and $27.24 short-paid by Administrations in 1933; the recurrent expenditure (excluding depreciation) is $378,473.32 and special expenditure $43,925.16, making a total of

$422,398.48, that is, the total expenditure is $237.78 more than the cess collected. Miscellaneous receipts (interest on investments, sales of rubber and publications, rents of houses) amount to $23,429.52.

From the balance sheet it will be observed that the total excess of assets over liabilities is ... $1,387,546 73

represented by

Land, Buildings and Furniture	...	$453,662 31
Plant, Machinery and Apparatus	...	45,980 75
Experiment Station	...	448,294 86
Stocks	...	1,851 36
Sundry Debtors (including contributions due by Administrations)	...	38,966 39
Investments	...	346,905 44
Cash	...	120,830 32
		$1,456,491 43

Less Sundry Creditors:			
Miscellaneous	...	$11,978 26	
Reserve for Staff Leave-pay and Passages	...	50,319 58	
Rubber Roadways Committee: balance of grant from Rubber Experimental Research and Propaganda Fund	...	6,646 86	68,944 70
			$1,387,546 73

Of the realisable investments and available cash amounting to approximately $437,757 it is expected that the sum of $200,000 may be required for the erection of new laboratories and offices for the Institute and a factory and buildings at the Experiment Station. The question of more suitable accommodation for the Institute (see *Annual Report 1933*, page 5) is still under consideration and may be settled in 1935, plans and estimates being in course of preparation.

Small-holders Advisory Service

The service adumbrated in the Board's Annual Report, 1933, was inaugurated on the 1st May, 1934, when nine Asiatic Rubber

Instructors were appointed and, after an intensive course of specialised training under the direction of the Director of the Institute, were, on the 1st July, posted to various stations in the Peninsula under the administrative control of the Department of Agriculture. Further reference to this service will be found in the annual report of the Director for 1934.

Technological and Advisory Division

In accordance with the recommendation of the Commission of Enquiry this Division was abolished on the 1st August, 1934, and the Chemical Division has been restored to its former basis.

Activities of the Institute in 1935

It may be appropriate to remark here that unfortunately the activities of all Divisions of the Institute will be seriously curtailed in 1935 owing to the incidence of home leave of members of the Senior Staff, retirements of members and the lamentable death of Dr. J. L. Wiltshire. Negotiations are, however, now in progress to recruit additional officers from Europe and it is expected that the staff will be considerably augmented during the second half of the year.

B. J. Eaton

Chairman of the Board

H. S. Blacklin

Secretary

Kuala Lumpur

8th February, 1935

INCOME AND EXPENDITURE ACCOUNT

Dr.

EXPENDITURE

		$ c.	$ c.
To	Experiment Station		38,940 47
,,	Board and Committees (Fees and Expenses) ...		2,649 51
,,	London Advisory Committee		11,960 24
,,	London Secretarial Fee		852 59
,,	Salaries and Allowances		195,698 20
,,	Provident Fund		11,049 70
,,	Staff Leave Pay and Passages		30,853 00
,,	Rubber Roadways Research		309 60
,,	Medical		1,599 44
,,	Travelling		7,263 37
,,	Office General Charges (Printing, Stationery, Postage, Telephone, Audit, Legal) ...		4,604 19
,,	Rents, Rates and Insurance		4,447 22
,,	Laboratory General Charges		847 54
,,	Upkeep Buildings (Offices & Residential Houses)		6,479 69
,,	Upkeep Laboratory Grounds		1,488 06
,,	Upkeep Furniture		639 10
,,	Plant and Machinery (Upkeep and running expenses)		7,934 22
,,	Lorry (running expenses)		2,081 31
,,	Workshop		94 07
,,	Laboratory Apparatus and Glassware ...		5,026 24
,,	Laboratory Chemicals		1,362 04
,,	Publications		
	issued by the Institute	9,154 81	
	grant to the Department of Agriculture for vernacular publications	2,000 00	11,154 81
,,	Library (New books and subscriptions to periodicals)		3,713 94
,,	Exhibitions and Demonstrations		1,095 51
,,	Small Holders' Advisory Service		
	Film Propaganda	1,433 85	
	Training of Agricultural Students ...	501 60	
	Asiatic Rubber Instructors	7,344 98	9,280 43
,,	Experiments (Field and Factory)		17,048 83
,,	Depreciation for year		39,151 51
			417,624 83
,,	Balance being Excess of Income over Expenditure for year carried forward ...		27,938 15
			$445,562 98

To	Excess of all Income over Expenditure carried to Balance Sheet	$27,965 39
		$27,965 39

Kuala Lumpur, 30th January, 1935.

FOR THE YEAR ENDED **31st DECEMBER, 1934**

Cr.

INCOME

			$	c.	$	c.
By Collections and Contributions by Administrations for the year	...	...			422,133	46
„ Interest on Cash and Investments	...	...			13,854	13
„ Miscellaneous Receipts :—						
Sales of rubber and budwood	...	...	2,780	57		
Sales of publications	...	...	1,570	66		
House rentals	...	...	4,632	00		
General	...	...	592	16	9,575	39
					$445,562	98
By Excess of Income over Expenditure for year brought down	...	...	...		27,938	15
„ Collections received in respect of the year 1933					27	24
					$27,965	39

(Sgd.) B. J. EATON
Chairman of the Board

(Sgd.) H. S. BLACKLIN
Secretary

BALANCE SHEET AS AT

LIABILITIES

		$ c.	$ c.	$ c.
Sundry Creditors ...	...	...		11,364 94
Deposits for Publications ...	...	...		613 32
Reserves:				
Laboratory Staff Leave Pay at 1st January 1934 ...	...	60,977 67		
Add Reserve for year	...	23,272 00		
		84,249 67		
Less Paid during year	...	46,793 33	37,456 34	
Staff Passages at 1st January 1934	...	15,104 01		
Add Reserve for year	...	7,581 00		
		22,685 01		
Less Paid during year	...	15,112 49	7,572 52	
			45,028 86	
Experiment Station ...	...	...	5,290 72	50,319 58
Rubber Roadways Committee:				
As at 1st January 1934 ...	...	...		6,646 86
Excess of Assets over Liabilities:				
Balance as at 1st January 1934	...	...	1,396,042 26	
Less amount debited for restoration of salaries of staff deducted in 1932 and 1933 ...	...	...	36,460 92	
			1,359,581 34	
Add Excess of all income over expenditure for year	...	...	27,965 39	1,387,546 73
Carried forward ...				$1,456,491 43

31st DECEMBER, 1934

ASSETS

	$	c.	Depreciation for year $	c.	$	c.	$	c.
LAND AND BUILDINGS:								
132 Ampang Road								
Land as at 1-1-34 ...		...		...	10,755	00		
Ampang Villa as at 1-1-34	16,758	45	507	83	16,250	62		
132a Ampang Road								
Building as at 1-1-34 ...	38,093	47	1,154	34	36,939	13	63,944	75
Land behind Ampang Villa								
as at 1-1-34 ...		...		...			5,029	35
5 Circular Road								
Land as at 1-1-34 ...		...		...	17,147	08		
Old Building								
as at 1-1-34 ...	13,053	25	395	55	12,657	70		
Three Houses								
as at 1-1-34 ...	68,941	65	2,089	14	66,852	51	96,657	29
163 Ampang Road								
Land as at 1-1-34 ...		...		...	31,440	35		
Old Building								
as at 1-1-34 ...	12,121	04	367	30	11,753	74		
Five Houses								
as at 1-1-34 ...	81,256	06	2,462	30	78,793	76	121,987	85
184/8 Ampang Road								
Land as at 1-1-34 ...		...		...	45,422	50		
Five Houses as at 1-1-34	73,956	26	2,124	89	71,831	37	117,253	87
LABORATORY BUILDINGS:								
As at 1st January 1934 ...	22,934	35	11,467	18			11,467	17
PLANT AND MACHINERY:								
Electric Plant								
As at 1st January 1934	2,305	85	576	46	1,729	39		
General Machinery								
As at 1st January 1934	12,444	55	1,866	88	10,577	67	12,307	06
FURNITURE:								
Residential Houses								
As at 1st January 1934	28,061	60	2,104	62	25,956	98		
Office								
As at 1st January 1934	9,315	58	698	67	8,616	91		
Laboratory								
As at 1st January 1934	1,961	70	147	13	1,814	57		
Store								
As at 1st January 1934	168	48	12	64	155	84		
Library								
As at 1st January 1934	840	79	63	06	777	73	37,322	03
Carried forward ...			26,037	99			465,969	37

BALANCE SHEET AS AT

LIABILITIES—*(Contd.)*

	$ c.
Brought forward	1,456,491 43

Carried forward	$1,456,491 43

31st DECEMBER, 1934

ASSETS.—*(Contd.)*

	$ c.	$ c.	$ c.	$ c.
Brought forward		26,037 99		465,969 37
LABORATORY EQUIPMENT AND APPARATUS:				
As at 1st January 1934	37,432 70			
Additions during year ...	3,440 47			
	40,873 17			
Less Sales of old Plant $130.00 Cost of apparatus over reserved in 1933 $474.78	604 78			
	40,268 39	8,053 68		32,214 71
MOTOR LORRY:				
As at 1st January 1934 ...	1,148 06	287 01		861 05
WORKSHOP EQUIPMENT:				
As at 1st January 1934 ...	703 45	105 52		597 93
R.R.I. EXPERIMENT STATION:				
Development Expenditure as at 1st January 1934	448,333 62			
Additions during year ...	4,628 55			
	452,962 17	4,667 31		448,294 86
Total Depreciation ...		39,151 51		
LIBRARY BOOKS AND PERIODICALS:				
As at 1st January 1934 ...			1 00	
Add Purchases during year ...			2,601 90	
			2,602 90	
Less written off ...			2,601 90	1 00
STOCKS:				
Petrol and Oil				
Laboratory ...	179 63			
Experiment Station ...	25 60		205 23	
Empty Drums				
Laboratory ...	145 50			
Experiment Station ...	160 00		305 50	
Stationery ...			592 70	
Sundry Materials				
Laboratory ...	143 39			
Experiment Station ...	603 54		746 93	1,850 36
SUNDRY DEPOSITS for water, telephones, etc.				
Laboratory ...			240 00	
Experiment Station ...			20 00	260 00
Carried forward ...				$950,049 28

BALANCE SHEET AS AT

LIABILITIES—*(Contd.)*

	$ c.
Brought forward	1,456,491 43

(Sgd.) H. S. BLACKLIN
Secretary

(Sgd.) B. J. EATON
Chairman of the Board

$1,456,491 43

I hereby certify that to the best of my knowledge and belief all

Kuala Lumpur,
30th January, 1935.

We have audited the above Balance Sheet and Income and Expen Institute and certify same to be correct according to the best of our of the Institute.

Kuala Lumpur,
7th February, 1935

31st DECEMBER, 1934

ASSETS.—*(Contd.)*

	$ c.	$ c.	$ c.	$ c.
Brought forward				950,049 28
SUNDRY DEBTORS:				
Administrations			28,477 70	
Staff			2,909 65	
Accrued interest			4,528 28	
General			2,645 85	
At Experiment Station			31 02	38,592 50
SUSPENSE:				113 89
INVESTMENTS:				
F.M.S. Government 4½% Loan 1931/59 Nominal value, $172,800/- ...			183,922 07	
Singapore Municipal 4½% Loan 1930/70 Nominal value, $15,000/-			17,507 94	
British 3½% War Loan, 1932/52 Nominal value, £17,000			145,475 43	346,905 44
CASH AT BANK AND IN HAND:				
London Advisory Committee for Rubber Research (Ceylon and Malaya) ...			1,633 25	
Chartered Bank, London			4,338 05	
Chartered Bank, Kuala Lumpur				
Board Account	58,547 90			
Rubber Roadways Committee ...	6,646 86			
Working Account	44,688 93			
Experiment Station	1,997 37		111,881 06	
Mercantile Bank of India Ltd., K. Lumpur Board Account			2,620 84	
Petty Cash				
Laboratory	47 59			
Experiment Station	309 53		357 12	120,830 32
				$1,456,491 43

liabilities to 31st December, 1934, have been brought into account.

(Sgd.) H. S. BLACKLIN
Secretary

diture Account with the books and vouchers of the Rubber Research information and explanations given to us and as shown by the books

(Sgd.) GIBSON, ANDERSON, BUTLER & CO.
Chartered Accountants
Auditors

ANNUAL REPORT

OF

THE DIRECTOR

Introduction

During the year under review, which constitutes the eighth complete year of the Institute's activities, several changes have occurred as a result of the recommendations of the Commission of Enquiry which were adopted by the Malayan governments and embodied in a new Enactment during the year.

Although these changes have naturally affected the work it can be stated that satisfactory progress has been made in a number of directions and that useful additions have been made to our knowledge both in respect of problems concerned with the cultivation of the rubber tree and the preparation and treatment of the raw product—latex and rubber.

As far as possible with a reduced staff, due to leave exigencies and other reasons, the tours of visits to estates in relation to botanical, soil, pathological and chemical problems have been continued. These visits have included all States and Territories in the Peninsula except Kelantan and Trengganu. The last-named State however was visited by one of the newly-appointed Rubber Instructors in order to advise small-holders, especially on methods of preparation of sheet rubber.

Apart from these tours, numerous individual visits to estates have been made by various research officers, in addition to advice conveyed in correspondence as shown in the summary relating to the advisory work of the Divisions.

Staff

Director

As a result of the recommendations of the Commission of Enquiry which were embodied in the new Enactment governing the constitution of the Institute, it became essential to appoint a Director. On the recommendations of the London Advisory Committee for Rubber Research (Ceylon and Malaya) the writer was appointed by H.E. the High Commissioner, Federated Malay States.

Botanical Division

No changes occurred in the personnel of the Division during the year; Mr. C. C. T. Sharp proceeded on leave on the 1st November and was absent for the remainder of the year. Mr. Sharp's re-engagement on the expiry of his leave was approved by the Permanent Committee.

Chemical Division

The Chemical Division suffered a severe loss on account of the unfortunate motor accident resulting in the death of Dr. J. L. Wiltshire on the 13th November. As a result of the abolition of the Technological and Advisory Division, which was recommended by the Commission of Enquiry, Mr. A. Moore, Field Officer, was attached to the Chemical Division with effect from the 1st August.

Pathological Division

Mr. A. Sharples, Head of the Division, retired from the service of the Institute on the expiration of his agreement on the 5th February. It was decided not to replace him for the present, since it appeared that the work of the Division could be carried out by two European officers, assisted by an Asiatic Graduate. Mr. R. P. N. Napper proceeded on leave on the 28th December on the expiration of his agreement and has been offered a new agreement on the expiry of his leave.

Soils Division

Dr. W. B. Haines left the service of the Institute on the expiry of his leave on the 31st October. Mr. Akhurst was appointed to act as Head of the Division. Mr. Akhurst proceeded on leave on the 28th December and Mr. Moore was appointed to officiate during his absence.

Mr. Akhurst has been offered and has accepted a new agreement as Senior Officer of the Division on the expiry of his leave. Mr. K. S. Pillay, Assistant Chemist, proceeded on leave on the 20th July and resumed his appointment on the 1st December.

Technological and Advisory Division

As a result of the abolition of the Technological and Advisory Division Mr. R. O. Bishop, M.B.E. left the service of the Institute on the 31st July, and Mr. A. Moore was transferred to the Chemical Division. The work of this Division will be absorbed in the Chemical Division, thus reverting to the previous situation.

Experiment Station

Mr. H. W. Foston continued to serve as Manager throughout the year.

As a result of the decision of the previous Board, it was decided to discontinue the services of a Visiting Agent and Mr. D. S. Gardner's services in this capacity were therefore terminated.

Office

Mr. H. S. Blacklin continued as Secretary throughout the year.

Library

Miss McInerny (Librarian) proceeded on leave on the 26th May. As a result of her marriage she relinquished her appointment on the expiry of her leave.

Mr. J. M. Hollway was appointed to act as Librarian on the 14th May, but was allowed to relinquish the appointment on the 31st May on being offered another appointment.

Mr. H. S. Blacklin (Secretary) was appointed to act as Librarian in addition to his own duties.

As a result of the reduction of meetings of the Board and Committees it was decided for the present to continue this arrangement.

General

Arrangements have been made to recruit two Chemists to fill the vacancies in the Chemical Division and one Soils Chemist to fill the vacancy in the Soils Division. It is desirable to state here that it was not possible to take steps to fill these vacancies until the new Board had decided the terms of appointments and had considered the regulations which had been drawn up by the old Board. These regulations were not finally adopted at the end of the year.

Advisory Work

Advisory work, in respect of visits by the staff to estates, visits by planters to the Institute and the Experiment Station, and correspondence, has been maintained as in former years and a number of lectures and demonstrations have also been given at various centres which are detailed in a later section.

The special tours arranged during the year were as follows:--

State	*Object*	*Visiting Officer*
Perak	Advice on factories and smoke-houses	R. O. Bishop
Malacca and Negri Sembilan	Oidium leaf disease	F. Beeley
Pahang	Inspection of budded areas	C. E. T. Mann
Perak and Kedah	Oidium leaf disease	F. Beeley
Perak and Kedah	Advice on factories and smoke-houses	A. Moore
Pahang	Oidium leaf disease	F. Beeley
Pahang	Inspection of budded areas	C. E. T. Mann
Johore and Negri Sembilan	Soils investigations	C. G. Akhurst
Kedah and Perak	Inspection of budded areas	C. E. T. Mann
Malacca and Negri Sembilan	Root diseases	R. P. N. Napper
Perak and Kedah	Factories and smoke-houses	A. Moore
Malacca, Negri Sembilan and Johore	Root diseases	R. P. N. Napper
North Johore and Malacca	Inspection of budded areas	C. E. T. Mann

The principal features in relation to advisory work have been tapping systems on mature seedling trees, the tapping of budded trees, the selection of clones for planting or replanting, Oidium leaf disease, the control of root diseases, the identification of and advice concerning natural covers, manuring of rubber and cover plants, replanting, preservation and shipment of latex, especially in relation to containers, and the drying and smoking of sheet rubber.

In relation to a number of these problems, standard instructions have been drawn up as pamphlets and replicated. These are issued to agency houses and estate managers on request. Judging by the number of applications received these have served a very useful purpose and have saved much time in replying to a number of enquiries. Further instructions, dealing especially with problems relating to replanting and root diseases are being prepared, both for use on estates and by the Rubber Instructors appointed under the Small Holders' Advisory Service. During the year 4808 letters including 3196 enquiries on planting problems

have been received and 3926 letters and reports have been despatched, exclusive of those dealing with the Institute's publications.

The principal enquiries in relation to estate practice and planting problems are shown in the following summary:—

Cover Plants, Natural Covers and Soil Conservation	...	243
Manuring	...	122
Replanting	...	109
Budding and Selection	...	264
Cover Plants (Identification)	...	70
Tapping (including experimental work)	...	298
Root Diseases	...	184
Stem and Bark Diseases	...	93
Leaf Disease (principally *Oidium Heveae*)	...	197
Fungicides and Insecticides	...	61
Latex Preservation and Concentration	...	336
Smoke-houses and Smoked Sheet	...	280
Coagulants and Rubber Preparation	...	232
Estate Factory Machinery and Plant	...	172

A detailed summary of the advisory correspondence of each Division is published as an Appendix to this report.

Correspondence, principally in relation to problems of preparation and treatment of latex and raw rubber, with the London Advisory Committee for Rubber Research (Ceylon and Malaya) has continued to increase as a result of the closer liaison with the research laboratories of that organisation.

Small-Holders' Advisory Service

A Small-Holders' Advisory Service, recommended by the Commission of Enquiry, was inaugurated during the year by the selection of nine Rubber Instructors from the students who had undergone the three years' course of training in agricultural science at the School of Agriculture, Malaya, at Serdang, and who had satisfactorily passed the final examination for the Diploma of the School. Eight Malay and one Indian Instructors were appointed on the 1st May. The Instructors were given a two months' intensive refresher course in relation to problems connected with rubber cultivation, principles of co-operation and methods of conveying instruction and advice to small-holders. The instruction in these classes was given by officers of the Co-operative Societies Department, the Department of Agriculture and this Institute.

On the 1st July the Instructors were allocated to various districts in the Straits Settlements and Malay States after consultation with the Director of Agriculture, S.S. and Adviser on Agriculture, Malay States. The Instructors are working under the control of the State and District Agricultural Officers of the Department of Agriculture and all technical advice is provided by the Institute. The nine instructors have been allocated as follows:—

Perak (North) and P. Wellesley	...	1
„ (Central)	...	1
Selangor	...	2 (One Indian)
Negri Sembilan and Malacca	...	1
Pahang	...	1
Kedah	...	1
Johore	...	2

It was considered advisable that the Instructors should concentrate their efforts for a period to a particular district in each State and after a period of at least six months be transferred to another district, if the progress made in the previous district was satisfactory.

It is intended to recruit additional Instructors in 1935 and to complete the cadre of 22 Instructors in 1936, so that eventually it will be possible to have at least two Instructors in each of the larger States and Settlements and one in the smaller. The complete cadre at present approved includes 14 Malays, six Chinese and two Indians for advisory work on holdings owned by these nationalities.

During the year the Instructor allocated to Pahang was, at the request of the British Adviser, Trengganu, lent for a period to that State to advise small-holders on the preparation of sheet rubber. In Kelantan useful work in relation to the improvement in preparation of sheet rubber had previously been inaugurated by the State Agricultural Officer.

Monthly reports are received from each Instructor on special forms drawn up in the Institute after consultation with the Director of Agriculture. These reports are submitted to the Institute through the Director of Agriculture and comments are made on them by the Agricultural Officer under whom the Instructor works, by the Chief Agricultural Officer of the Department of Agriculture, the Director of Agriculture and the Director of the Institute. Where necessary, advice on various technical matters is then sent to the Instructors by means of circulars or leaflets or by means of a direct report or letter dealing with a particular problem. The six monthly reports already received indicate that considerable progress has already been

made in the districts to which Instructors have been appointed. Most of the reports also indicate that the Instructors are taking an intelligent interest in their work and a sympathetic attitude to the small-holder. This applies particularly to improvement in the preparation of sheet rubber and in the treatment of Mouldy Rot disease. In some cases in which the owners of small-holdings pay their labourers a fixed sum for the rubber collected and take no further interest in the holdings, progress is slow, since all operations of tapping, collecting, purchase of coagulants and preparation of the rubber are left entirely to the labourers, who are naturally not prepared to carry out extra work such as the treatment of Mouldy Rot or take much care in the preparation of the product.

Valuable information has been obtained in respect of types of coagulants used, as a result of a report from one Instructor and subsequent investigation made in the Chemical Division of the Institute. Every endeavour is being made to advise small-holders to use only approved coagulants—formic or acetic acid. It is also evident from the investigations of this problem that small-holders are paying in many cases a very high price for their coagulants.

In view also of the fact that the small-holder loses money by selling wet rubber to dealers, every endeavour is being made to point out the disadvantages and the losses which accrue and to persuade them to prepare and sell only dry sheet rubber, preferably smoked.

In relation to disease control it is emphasized that the Instructors' functions are purely advisory so that they must endeavour to persuade the small-holders of the advantage of satisfactory control of diseases, especially Mouldy Rot, and of improvement in the methods of tapping. Evidence is available that progress, although slow, is being effected in this direction.

Rural Lecture Caravan

The Rural Lecture Caravan controlled jointly by the Co-operative Societies Department, F.M.S. & S.S., the Department of Agriculture, S.S. & F.M.S. and this Institute has continued to function satisfactorily during the year and large audiences have attended the lectures and demonstrations given in the districts visited. A microphone with loud-speaker attachment has recently been added to the equipment, on account of the large out-of-door audiences present at some centres. In relation to rubber cultivation, lectures on the preparation of sheet rubber and on Mouldy Rot disease and its control, illustrated by means of lantern slides, have been given in all districts visited, in which rubber is cultivated by small-holders. In view of the inauguration of the Rubber

Small-Holders' Advisory Service, it is intended to augment the lectures in respect of rubber and to give advice especially on methods of preparation of sheet rubber. In this connection a set of twenty-eight lantern slides, together with brief narratives have been prepared in the Institute for use in the Caravan. It is also intended to prepare models of smoke-houses and factories suitable for small-holders and exhibits of good and defective sheet rubber.

It is now realised that, although the films which have been used previously are of value and attract considerable interest, the use of lantern slides for more intensive instruction is desirable. The caravan has visited the following districts during the year:—

Negri Sembilan: five centres

Pahang: twenty-five centres

Perak: Krian District—six centres; Larut and Matang—six centres; Kinta—five centres; Lower Perak—seven centres

Selangor: Kuala Langat district—six centres; Sabak Bernam district—three centres

Malacca: eleven centres

Province Wellesley: five centres

In most cases, the caravan remained in each centre for two days, as this was found to be desirable in preference to the former practice of giving lectures and demonstrations on one day.

Co-operation with other Malayan Institutions

The Director has continued to serve on the following committees:—

(i) The Advisory Committee of the Department of Agriculture, S.S. & F.M.S. (ii) The Publicity Committee of the Department of Agriculture, S.S. & F.M.S. (iii) The Agricultural Pests Advisory Committee of the Department of Agriculture, S.S. & F.M.S. (iv) The Public Gardens Committee (Kuala Lumpur) (v) The Marketing and Propaganda Committee of the Co-operative Societies Department, S.S. & F.M.S.

Liaison with other Institutions

Contact has been maintained with the Rubber Research Organisations in Netherlands India, *viz.* the A.V.R.O.S. Proefstation in Sumatra and the Proefstation West Java, on a number of problems of mutual interest. Correspondence has also been exchanged with the Rubber Research Scheme (Ceylon) which, together with this Institute, is working in close collaboration with the laboratories of the London Advisory Committee for Rubber Research (Ceylon and Malaya) on problems relating to consumption research. In addition, correspondence on a number of

problems in relation to manufacture, treatment of latex and preparation of raw rubber has been maintained with rubber manufacturers and latex consumers in Great Britain and the United States of America. Contact has also been maintained with the Research Association of British Rubber Manufacturers.

Dr. d'Angremond, Director of the A.V.R.O.S. Proefstation, Sumatra, paid a visit of about 14 days to Malaya to discuss various problems, to see the work of the Institute and to visit various estates in order to see the recent progress in relation to rubber cultivation in Malaya. A tour of visits was arranged by the Institute. Mr. Bangham, Botanical Research Officer of the Goodyear Plantations, Sumatra, Dr. de Jong, Plant Pathologist of the Holland American Plantations, Sumatra, and Dr. Muller, Agricultural Adviser to Harrisons and Crosfield, Sumatra, also visited the Institute for a similar purpose.

Co-operation with London Advisory Committee Laboratories

The arrangement made at the beginning of 1932 for collaboration with the Research Staff of the London Advisory Committee Laboratories has continued to function satisfactorily during the year. As a result of the adoption of the recommendations made by the Commission of Enquiry it is anticipated that still closer collaboration will be effected in the future. As far as the greater part of the investigation work on raw rubber and latex is concerned, collaboration is effected chiefly directly between the Director and the Head of the Chemical Division of the Institute and the Superintendent of laboratories of the London Committee. This direct contact by correspondence is undoubtedly of considerable value, especially in relation to the smooth working of the scheme.

Co-operation with the Rubber Growers' Association

Collaboration with the Technical Research and Development of New Uses Committee of the Rubber Growers' Association, and with the Rubber Producers' Research Association under the aegis of the Rubber Growers' Association, has been maintained. The appointment of a liaison officer by the Rubber Growers' Association has facilitated co-operation. Requests for various samples of rubber in connection with investigations being conducted at home have been met and correspondence exchanged on various problems relating to consumption research. Detailed reports of investigations being carried out by the above organisations are received regularly at the Institute.

The Institute has also collaborated with the Association in providing exhibits required for a rubber exhibition held under the

auspices of the Association at the Science Museum, South Kensington, London.

Soil Investigations

Natural Undergrowth in Soil Regeneration

In view of the correspondence which has continued during the past year in the local press in regard to the so-called "rubber forestry" methods, it appears desirable to include in this report some further comments on this problem.

It does not appear to be fully realised that this problem is related in its broad aspects with a situation that has arisen and become intensified in many parts of the world, owing to the rapid development and increase of areas devoted to various crops, especially in the tropical rainfall belts where rainfall is intensive and causes maximum soil erosion. Apart from such belts, however, the problem has become no less serious in certain temperate countries especially the United States of America where millions of acres of land under agriculture have been rendered useless. In these States a body of men, calling themselves the Civilian Conservation Corps, voluntarily saving soil as a recreation, has adopted the slogan "Save the surface and you save all". In Africa too, the enormous damage done, not only by the loss of soil due to erosion, but by the loss of underground water due to run-off of rainfall on denuded soils, is stated in a recent publication* as likely to produce "The Great South African Desert uninhabitable by man." Attention to the situation in Ceylon has been referred to on a number of occasions and a Committee was appointed by the Government a few years ago to make recommendations.

At the present time considerable technical literature of the Departments of Agriculture in various countries is devoted to this problem.

It has to be realised that the top 9 to 12 inches of soil contain the principal reserves of nitrogen accumulated during hundreds of years. In addition the physical nature of this top soil under forest conditions which enables the layers to absorb rainfall, the "brake" effect of the forest in reducing the impact of the rainfall on the soil surface and the shading effect of forest cover in reducing the temperature of the top soil, are also of supreme importance.

In this connection it is apposite to quote the following from two recent publications:—

"The basis for the reduction of our crop yields, in spite of the increasing use of artificial fertilisers is found only in the

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* *Bulletin no. 1 of 1935*, Department of Agriculture, Kenya.

increasing lack of humus in our soils, because the destruction of humus is hastened by the addition of artificial fertilisers without sufficient provision being made for the proper supplement of organic matter. A healthy humus economy forms the surest basis both for agricultural and animal husbandry. The use of mineral fertilisers promises full benefit only when the soil is sufficiently enriched in humus." (*Landsberger landwirtschaftliches nachrichtenblat* (No. 16 of 1934), published by the Prussian Agricultural Experiment Station, Landsberg.)

"Of the many soil constituents the one that most affects the agriculturist in the tropics is perhaps that mixed collection of organic matter spoken of as humus. It is usual to refer to tropical soils, especially those of volcanic origin, as having a high inherent fertility. In reality the contrary is the case. What one sees under tropical forest is not the utilisation of immense supplies of plant nutrients but the rapid turnover of a medium supply. When such virgin soil is brought under cultivation, the accumulated supply of nutrients, present largely in the humus, is exploited. During the first few years bumper crops are obtained, but sooner or later, the humus drops to a low level and so do the crop yields. The physical condition of the soil too changes, it becomes less easily worked, its water absorbing capacity is decreased and its liability to erosion increased. A great deal of the nutrient requirements of crops can be met by means of mineral fertilisers, but the physical character of the soil cannot be so improved. It is essential to increase the humus content of the soil by judicious organic manuring. Not only does humus improve the texture of the soil by cementing the ultimate particles together into complex crumbs, thus making it easier to work, improving its water absorbing capacity and decreasing liability to erosion, but experience has shown that the utilisation of mineral fertilisers is enhanced." (*Bulletin no. 9, 1934, Organic Manures*, Department of Agriculture, Kenya).

In the case of a permanent tree crop, such as the rubber tree, the problem of prevention or reduction of deterioration is simpler than with an annual crop, provided a cover is established early.

In the case of rubber cultivation in Malaya, two aspects of the problem require consideration, *viz.* (a) the prevention of erosion in new clearings, (b) the maintenance of soil fertility or the regeneration of soil on "mature" rubber areas. The latter is receiving most attention owing to the needs of the situation. In the case of the former, the Institute is developing a number of areas on hilly and undulating land on the Experiment Station, on which natural covers are being allowed to develop from the time of felling and burning. In order to encourage such covers and

also to reduce the loss of material due to heavy burning of the felled jungle, only a light burn, shortly after felling, has been adopted. Control plots with various leguminous covers are also being established. Several estates have also opened up new areas of jungle land on similar lines. It has been shown that the growth of covers during the early stages of growth of the rubber tree, i.e. up to say the 5th to 6th year, retards the growth of the main crop and thus delays the tapping of the tree and the early return of revenue. On the other hand, there is no doubt that the establishment of cover plants during this period will result in the maintenance and improvement of subsequent yields and a reduction of expenditure on manuring at a later date. Since the greatest damage is caused during the first five to six years, when the shade of the main crop is insufficient, any retardation in growth caused by cover plants must be considered from the ultimate rather than from the immediate return of revenue.

In relation to the establishment of natural covers on "mature" rubber areas, the problem is not only one of maintenance of satisfactory soil conditions, but in many cases of a regeneration of the soil by the growth and decay of the covers. Where the deterioration has not been excessive, a satisfactory regeneration and balance may be established in a few years. In extreme cases, and there are such areas planted with rubber in Malaya, regeneration may take 50 to 100 years or more and may not be economic. In such cases it can be stated that no other method of regeneration or amelioration, such as the application of fertilisers, will be economic.

I should like again to emphasize that this is essentially a soil problem in which investigation by both soil scientists and botanists (ecologists) is necessary. It is therefore a problem of equal importance and fundamental to forestry and to agriculture, especially in relation to permanent crops.

There is too great a tendency to assume that definite recommendations can be made and published to suit all cases, whereas each individual case must be treated on its merits. Similar remarks apply to manuring. In some instances it may be more economic to replant with high-yielding material and to apply fertilisers; in others manuring of the present stand of mature trees may be economic. This will depend on at least two unknown factors (a) the future price of raw rubber and (b) whether the high yields of budded rubber or certain clonal seed will at some future date render areas yielding say 450 to 500lb per acre unremunerative. Where root disease is present to such an extent as to cause a fairly rapid loss of the trees, the best procedure is undoubtedly to replant with high-yielding material.

There is also an additional factor with which the scientist, who must take the long view of the ultimate good not only of the industry but of the country, has to contend, *viz.* the demand by either Directors or Shareholders for immediate dividends. This view has been presented to us not only in certain publications but also by Directors who have reached an age at which they wish to draw dividends for the few remaining years of their life. While appreciating this point of view, it should not be allowed to affect our recommendations for the future welfare of the individual estate or the industry generally.

Cover Plants

In addition to the interest taken in the development of natural covers under "mature" rubber, continued interest has been maintained in the establishment of leguminous covers in newly-planted areas. The value of the bushy leguminous covers on the heavy clay soils in increasing soil aeration and in providing organic matter by periodic slashing is also being realised.

Useful results have also been obtained by one of the fertiliser companies in the cultivation of bush covers by the application of fertilisers in "mature" rubber areas.

It can safely be stated that in the development of new rubber plantings, the clean-weeding policy of the past 25 to 30 years will no longer be adopted.

Manuring

In the early part of the year, owing to the continuation of the slump, little or no interest was taken in manuring, since in most cases, no money was available for such work. With the introduction of the Rubber Regulation Scheme and the resultant increase in value of the raw product, considerable interest in this problem was again evinced by many estates and numerous enquiries for advice were received during the latter half of the year. In addition, schemes recommended by the fertiliser firms in Malaya were referred to the Institute, resulting in a useful collaboration and liaison.

Although useful information is accumulating from various experiments laid down a few years ago, it is obvious that in the case of rubber cultivation, finality is not likely to be reached for some years and many problems remain unsolved. In the case of some estates on which fertilisers were applied three to four years ago, increased yields are only just beginning to be revealed from the bark which has renewed since the application of the fertilisers and as a result of resting the trees. In one case, where fertilisers

were applied in 1931 and the trees were rested for 19 months (owing to the poor yields and the slump) increases of yield of about 60 per cent are now being obtained, while the control areas, also rested, have shown little or no improvement. This illustrates the delayed reaction which may occur in the case of mature trees on a poor soil, combined probably with excessive tapping in the past and consequent poor bark renewal, and also indicates how difficult it is to make any definite statement on the economics of manuring such trees unless one can prophesy the market price of the product.

In the case of mature trees which are only beginning to deteriorate, owing to soil conditions, all that can be said at present is that manuring, combined with the encouragement of suitable natural covers, will undoubtedly maintain and in some cases improve yields. The economics of manuring will depend on the price of the raw product in relation to the cost of application of the fertilisers. The latter will amount to $10/- to $20/- per acre possibly every two years, although with the development of covers, it may be found after a few years that the application of fertilisers can be reduced or stopped.

Apart from exceptional sites, it can be stated that nitrogen is the most essential requirement, since the loss of this plant nutrient from the humus in the surface soil has been the greatest.

In relation to manuring generally in the case of "mature" trees in which the yields have deteriorated considerably or are beginning to deteriorate and where foliage is also showing signs of deterioration, we are not yet in a position to state definitely whether the application of nitrogen only or the application of a "balanced" fertiliser containing nitrogen, phosphate and potash is essential, since sufficient results are not yet available. Some recent results indicate that in the case of "mature" trees, only nitrogen may be necessary in most cases. This, however, would not apply to trees grown on light soils in which potash in particular and phosphate are deficient. In the case of young trees on replanted areas, the application of a complete fertiliser containing potash, phosphate and nitrogen is usually essential.

Weed-killers

Since, owing to the slump, a number of estates have been neglected to such an extent that excessive growths of bracken, stagmoss and grasses have been allowed to develop without control, a demand has arisen for a more economic method of eradication of such growths than by slashing or pulling. The use of most of the well-known weed-killers is however limited on account of the frequency of rain and also the low cost of labour.

As a rule weed-killers are more economic in countries where the cost of labour is high.

Replanting

Considerable interest is being taken in replanting problems on "uneconomic" areas. Here again no hard and fast generalisations can be stated since, on some areas, soil deterioration has been so great, owing to previous history of cultivation and treatment, that satisfactory growth cannot be attained without considerable expenditure on manuring and development of cover plants to improve the soil. In many cases, however, especially where the decrease of yield is due largely to the continued loss of trees from root disease, or where the soil has not deteriorated excessively but where yields are declining, replanting with high-yielding material is undoubtedly advisable.

This problem again is one concerning which no general recommendations can be made to cover all cases. Where root disease is confined to isolated areas, it is only necessary to dig over completely and to remove all infected material from such areas. If areas are known to be free from root disease, the tap roots and laterals of the existing stand can be left to decay in the ground, thus reducing the cost of felling and clearing. If root disease is disseminated throughout the whole area to be replanted, thorough digging and removal of all infected roots of the existing stand of trees are essential.

Botanical Investigations

The research investigations of the Botanical Division have followed the lines described in the *Annual Report* for 1933. Steady and satisfactory progress has been made in various directions, including work on vegetative propagation, physiological studies, especially in relation to tapping systems, anatomical studies of the latex-bearing tissues, which have an important bearing on the problem of physiology in relation to latex production and yields, the yields of budded trees and the production of high-yielding material from "selected" seed.

During the slump period of 1931 and 1932 opinions were expressed that work in relation to improvement of planting material, especially in respect of seed selection, which is necessarily slow, should be curtailed for the study of problems of possibly more immediate application, such as tapping experiments on the present stand of ordinary mature mixed seedling material; more recently opinions have been expressed by the London Advisory Committee that work in relation to seed selection should

be in the forefront of our investigations; it is therefore fortunate that a certain amount of material had previously been established at the Experiment Station. In this connection special attention is drawn to the remarks made by the Head of the Botanical Division in the first paragraph of his report in relation to policy in connection with this aspect of botanical research.

Attention may also be directed to the collaboration of the Chemical Division with the Botanical Division in regard to investigations of the properties of clone latex and the effect of tapping, seasonal changes and other factors on the properties of latex. Apart from its value in relation to the quality of latex and raw rubber for manufacturing purposes, such work has an important bearing on the problem of the physiology of latex production. It is unfortunate that this work has been slowed up by the unfortunate death of Dr. Wiltshire. The programme of work in this direction is however being continued and will receive more detailed attention on the arrival of the newly-appointed chemists to the staff of the Chemical Division. It will thus I trust be realized that the problem of the physiology of latex production is receiving considerable attention both from the botanical and bio-chemical standpoint.

Importation of Planting Material

The following records have been kindly supplied by the Adviser on Agriculture, Malay States.

The figures refer only to the first half of the year, since it will be realized that all importation and exportation of planting material was prohibited on the introduction of the International Rubber Regulation Scheme.

Budwood imported	...	34¾ metres
Budded Stumps	...	10
"Selected" Seed	...	nil

The budwood includes 12 metres imported by the Institute, while the remainder includes material from thirteen different clones of which twelve were of Sumatran origin. Ample budwood of all the more important Netherlands Indian clones is now available in Malaya, and budwood of proved Malayan clones of equal or higher value is also available.

Vegetative Propagation (Budding)

No new information is available in regard to the technique of budding and the methods at present in use are satisfactory. Investigations on the treatment of the pruning cut, especially in the case of large stocks, have shown the unsuitability of black

disinfectant dressings. The most promising results in relation to healing of the pruned cut on the stocks have been obtained by the application of a clay paste containing cattle manure together with additional protection of the pruned cut with a covering of hessian (gunny sacking).

Preliminary experiments on the vegetative propagation of stocks have been carried out with seedlings and young buddings of various clones. It is too early to make any definite statement on the practical application of these experiments.

Studies of the growth of budded trees have been continued both on the Institute Experiment Station and on estates, especially in relation to the value of certain clones for replanting. The initial slow growth in girth and branching habits of clone B.D.5. has been confirmed by extended observations. When the lateral branch system is well established, however, girth increase improves rapidly.

Records of nine well-known clones planted in randomised plots at the Experiment Station are given in Table I in the Report of the Botanical Division.

Records of growth of five of these clones and an additional clone on a replanted area are given in Table II of the Report of the Botanical Division.

The slower growth on replanted areas is marked and indicates the necessity of manuring when replanting. The effect of manuring in increasing girth is well shown in Table III of the Report of the Botanical Division.

Records of growth of various clones on a number of estates confirm those given in the *Annual Report* 1933. These records enable us to make recommendations for the choice of clones on different soil types as indicated in the Report of the Botanical Division.

Further details of the influence of density of planting on growth of budded trees have been recorded. The retarding effect of overcrowding is now becoming apparent on the trees at four years of age.

Observations have been continued on the relationship between stock and scion, especially in relation to vigour of the scion on old and young stocks. It would appear that with two-years-old buddings, the growth of those on young stocks shows a development equal to those made on larger stocks, which may be due to the slower healing of the pruned cut on the large stock.

Further buddings on twin seedling stocks have been carried out at the Experiment Station. It will not be possible to determine the influence of the scion on the stock until these buddings and other high buddings reach the tapping stage.

Seedling stocks from seed of well-known clones have also been planted for field tests on their possible value as budding stocks.

Physiology of Hevea in relation to Latex Production

These investigations include all experimental work on different tapping systems on both seedling and budded plants, also anatomical studies of the structure of the latex-bearing tissues in relation to latex production and a study of the composition and quality of latex, *i.e.* bio-chemical investigations.

Further evidence is available as to the more productive yield of the half left-to-right spiral cut compared with the "V" cut during the early years of tapping.

Details of the results of seven different methods of tapping compared with the alternate-daily system of tapping as a control on mature seedling trees are given in the Report of the Botanical Division.

The results obtained over a period of 18 months confirm those already published for the first year of these tapping experiments. The yields of the various A.B.C. systems of tapping and resting are gradually rising in relation to the control and it appears that short periods of tapping and resting are preferable, at any rate during the early stages of transition.

The so-called "Sunderland" systems are inferior to the A.B.C. systems in respect of yield but slightly superior in respect of tapping cost. The double-four system has so far given the most promising yields and also reduces cost of tapping. Its chief disadvantage is the high proportion of scrap rubber.

Studies of various tapping methods on budded trees have been continued on the Pilmoor Estate clones the records of which are given in the Report of the Botanical Division. Renewal of bark has been very satisfactory. On all clones the daily alternate-monthly system of tapping has given yields slightly higher than those from alternate-daily tapping. This work will eventually be extended to budded trees on the Experiment Station.

Bio-chemical work has been carried out chiefly on the latex of these clones.

Satisfactory yields have been maintained in renewed bark of 6-7 years of age on clone Glenshiel No. 1.

Anatomical investigations on the sieve-tube system of a number of high-yielding budded trees and high and low-yielding seedlings have been continued. The results so far obtained will be published in the next number of the Institute *Journal*.

The investigation reveals a close correlation between yield and degree of development of the sieve-tubes especially in respect of high and low-yielding material. In the case of medium yielders

the correlation is not so close, so that some other factor may also be involved. It is too early yet to make any definite statement in regard to the practical application of the results of this investigation for the elimination of low-yielding material at an early age.

Selection and Breeding

Reference has already been made to the importance of this aspect of our work for the improvement of planting material. This is also reflected in the enquiries received from estates as to the value of clonal and other "selected" seed compared with budded material for replanting.

Test-tapping of various crosses from hand-pollination at the Experiment Station has been continued, and indicate the value of the planting material already established, especially in respect of crosses of Pilmoor clone A.44 with other families. More complete details of this work are recorded in the Report of the Botanical Division.

Seedlings from isolated seed gardens and from buddings of proved clones have been established at the Experiment Station during the year.

Test-tapping Experiments

Work on test-tapping of young trees has been continued. The correlation between the yield obtained during the first test-tapping at three years of age and records from subsequent test-tappings have been calculated. The result shows that the early test-tapping is for practical purposes reliable as a basis of classification.

A very high degree of correlation is also shown between the yield over a short period of test-tapping (five days) and the yield over the whole period, which simplifies the number of actual records necessary.

Indigenous or Natural Covers

Reference to this problem has already been made under the heading "Soil Investigations".

The Botanical Division has collaborated with the Soils Division in the ecological study of this problem in relation to the changes in composition of natural flora by different methods of treatments of slashing and pruning. Further work is however essential before any definite recommendations can be made. Secondly, as has been stated elsewhere, the flora on different soil sites will vary considerably, so that general recommendations to suit all conditions are not possible.

New blocks have been opened on the Experiment Station for the comparison of natural covers under different treatments with both bush and creeping leguminous covers from the date of felling and planting.

Advisory Work and General

The summary of advisory correspondence given on page 20 of this report, together with the complete analysis of correspondence on botanical problems published as an appendix illustrate the problems which are at present of most interest to the planting community.

In connection with advisory correspondence, attention may also be drawn to the question of extending field experiments on estates since this is an important aspect of our work especially in relation to botanical and soil problems.

Diseases and Pests

Fortunately, during the year there has been no special epidemic to record and investigations have been confined to those diseases of the rubber tree which are already fairly well-known and recognised. In connection with these, however, there is still much to be learnt and satisfactory progress can be recorded in a number of directions as a result of investigation and experience.

As in previous years, it is convenient to discuss the diseases of the tree under (a) root diseases (b) diseases of the tapping panel (c) stem and branch diseases (d) leaf diseases (e) insect and animal pests.

Root Diseases

The investigations carried out on the three principal root diseases—White Root Disease (*Fomes lignosus*), Red Root Disease (*Ganoderma pseudoferreum*) and Brown Root Disease (*Fomes noxius*) have confirmed the work of previous years as to the relationship existing between these diseases and the methods of control in young and mature rubber areas.

Particular attention is being paid to the incidence and control of these diseases on areas on which natural covers are being developed and to the treatment necessary for replanting.

The incidence of root disease in a number of old rubber areas warrants the replanting of such areas with high-yielding material, rather than the treatment of the present stand. The results of recent investigations will be published in due course.

During the year, the increasing importance of *Fomes noxius* as a root disease has been observed.

PANEL DISEASES

(a) *Mouldy Rot (Ceratostomella fimbriatum)*

This disease has been kept under control during the year both on large estates and on small-holdings. The system of distribution of fungicides to small-holders by officers of the Department of Agriculture has proved satisfactory except in a few districts, where treatment is not carried out systematically by small-holders. No new fungicides have been added to the "White List" although a number have been examined and found to be unsatisfactory, chiefly because, while they destroy the fungus, they damage the renewing bark.

(b) *Brown Bast*

A number of enquiries have been received in relation to Brown Bast. The only satisfactory method of prevention is to adopt a less severe system of tapping. A circular describing the disease and its cause and method of prevention and control has been prepared by the Pathological Division.

(c) *Sun-Scorch*

A number of cases of damage to the tapping panel which proved to be due to sun-scorch again occurred during the very dry hot wintering period when, owing to the leaf-fall, there was little or no shade. In such cases and in others where the application of a fungicide to the tapping panel is recommended the addition of a thin coating of white-wash is advocated in order to reduce the temperature of the surface of the panel. Experiments have shown that high temperatures causing serious damage may be produced when black-coloured fungicides are applied.

STEM AND BRANCH DISEASES

Pink Disease (Corticium salmonicolor)

Although this disease is still prevalent in certain districts, no special outbreak has occurred and only a comparatively few enquiries have been received.

LEAF DISEASES

Oidium Heveae

The abnormal climatic conditions during the wintering and refoliation period resulted in a wide-spread occurrence of *Oidium Heveae*, but the heavy rains prevented serious leaf-fall, by helping the new leaf to develop rapidly. Wintering was delayed

by heavy rains in January and was generally very irregular owing to the climatic conditions. Early in March the weather became dull and showery with heavy mists and low clouds. Refoliation and the growth of the new leaf was retarded, providing a condition suitable for the attack of the fungus.

In only a few cases was the leaf-fall caused by the disease serious although leaf-fall was reported in a number of districts from which no reports had been received previously. This, however, may be due to the fact that knowledge concerning the disease is increasing and that a special leaflet was issued from the Institute to every estate in Malaya in January, requesting managers to report all cases of leaf-fall and to send specimens of diseased leaves to the Institute for diagnosis.

Sulphur-dusting for control was carried out on a number of estates, but in many cases the results were unsatisfactory owing to the quality of sulphur available, to the unsuitability of some of the dusting machines and to interference by rain. Investigations since carried out have resulted in methods for improving the dusting quality of the sulphur. The type of dusting machine available is, however, by no means ideal.

It may be of interest to Malayan producers to record that in Ceylon two views are held in regard to the treatment of this disease. One school of thought considers that manuring is a remedy while the other pins its faith on preventive treatment by sulphur-dusting.

There can be little doubt from the experience already gained that sulphur-dusting is the only satisfactory preventive treatment at present known. At the same time, the application of fertilizers enables the trees to make a more rapid recovery from the attack and provides plant nutrients to replace those lost in the leaf-fall. On soils which are deteriorating owing to clean-weeding or to the lack of satisfactory methods of conservation the periodic leaf-fall caused by the disease will have a worse effect on bark renewal and yields than in the case of good soils or soils which have been manured. Manuring in itself is not a cure for the disease but undoubtedly assists in the recovery of the trees from an attack of the disease. In many cases therefore both sulphur-dusting and manuring are necessary to maintain satisfactory bark renewal and yields.

Insect and Animal Pests

(a) *White Ants (Coptotermes curvignathus)*

This pest, for which no really successful remedy has been discovered since the plantation industry was started, has continued to be troublesome especially in areas of young rubber.

Regular inspection and treatment of runs and nests with poison dusts is the only satisfactory method of eradication at present known.

(b) *Cockchafer grub (Psilopholis grandis)*

Although this new Cockchafer pest has not caused any serious damage, three new small centres of infection have been reported.

The grub of this beetle or closely-related forms have been reported also from other countries. The Institute has been in correspondence with the Department of Agriculture, Queensland, where a similar grub is a very serious pest of sugar cane and also attacks other crops, and with the Department of Agriculture in Zanzibar, where an outbreak of a similar pest has been reported as attacking clove trees.

No information of any value in relation to economic methods of treatment has been received. The pest is normally kept in check by natural predators.

(c) *Caterpillars*

A number of caterpillars have been reported as causing damage on cover plants and natural undergrowth, but no report of damage to rubber has been received. The caterpillars, however, are frequently a nuisance since the hairs or spines produce irritating sores on the legs of the labourers. Generally the caterpillars have been very local and temporary so that control by means of poison sprays has not been recommended.

(d) *Spider Pest*

A small red spider has been responsible for leaf-fall resembling that caused by *Oidium Heveæ*. This spider has been found in conjunction with the two leaf diseases, *Helminthosporium* sp. and *Gloeosporium* sp. as well as with Oidium.

The leaf-mite *Tarsonemus translucens* has also caused similar damage.

When damage is serious, dusting with sulphur is recommended as in the case of Oidium leaf disease.

(e) *Snails and Slugs*

A number of cases of damage to young seedlings and buddings by snails and slugs have been reported. No satisfactory methods of control are known, apart from the application of poisons to cover plants if these are present. The application to the rubber trees of a preventive band of some repellent substance which does not injure the bark also prevents these pests from climbing.

(f) *Rodents*

No reports have been received during the year of any special damage caused by rats, squirrels or porcupines.

Chemical Investigations

In the *Annual Report* for 1932 reference was made to the value of investigations on raw rubber and applications to new uses which do not depend on the elastic, resilient or insulating properties of the product. It is pleasing to note that promising developments are taking place both as a result of investigations which are being conducted under the auspices of the Technical Research and Development of New Uses Committee of the Rubber Growers' Association and also as a result of research carried out by manufacturers. In this connection might be mentioned chlorinated rubber products, a new resinified rubber produced by oxidation, the use of rubber in paints and thermo-plastic products. Investigations in relation to crumb or powdered rubber have also made considerable progress, judging from the types of product now prepared. In connection with crumb rubber the Institute has collaborated with the staff of the London Advisory Committee and also with a large Corporation in the United States of America which has produced an excellent series of powdered rubbers of varying composition. In addition the Institute has collaborated with the Technical Research and Development of New Uses Committee of the Rubber Growers' Association in the preparation of raw rubber suitable for the manufacture of a de-odorized product.

Investigations on "soft" rubber, and also on a rubber having a low water-absorption value for electrical insulation purposes, are in progress. A large number of specially-prepared samples of raw rubber have been despatched to the laboratories of the London Advisory Committee for Rubber Research (Ceylon and Malaya). Particulars of the investigations carried out in the laboratories of this Committee are included in the Annual Report of the Committee and the Appendix thereto which are published in this Report.

As stated in the Report for 1933, it will be necessary to arrange direct contacts between the consumer and the producer for the preparation of any special types of raw rubber required for specific purposes. If extra expenditure is involved in the preparation of such types of rubber a premium over the market price will be necessary, as in the case of sole crepe, concentrated latex or other special preparations made on the estate. There are indications that consumers are becoming interested in this aspect

of the problem and are making direct contacts with certain estates for their requirements. It is, however, useless to recommend any particular method of preparation of the raw material unless an estate has a definite market for the product. Smoked sheet and thin pale crepe will therefore continue to be the standard output of estates, until a demand is received for some special type of raw material.

Latex Constituents

Owing to pressure of other work and shortage of staff it has not been possible to make any progress with work under this heading.

Latex Preservation

The export of concentrated and normal latex continues to increase. One large group of estates exports the whole of its crop in the form of concentrated latex, while another group continues to export normal field latex. It is of interest to record that a considerable proportion of such latex is applied to the manufacture of new products and to new uses, rather than as a substitute for raw rubber for articles at present manufactured, so that its application involves an increased consumption.

The most important investigation carried out by the Chemical Division of the Institute during the year has been the determination of the cause of the discolouration of latex, concerning which numerous complaints have been received from consumers. This investigation, which has created considerable interest, has shown that this discolouration is due to colloidal iron sulphide produced by contact with the metal containers and accelerated by incipient decomposition of the latex. Arising from the results of this investigation the problem of suitable treatment of the interior of metal containers to prevent such discolouration has led to the examination of a large number of products for painting or spraying the containers. So far no entirely suitable product has been evolved, although one or two are very promising. Investigations are however being continued. It has been shown that it is essential to add ammonia as a preservative as early as possible, in order to avoid incipient decomposition of the latex in the field or in the estate factory. Rustless steel containers have been experimented with, but are not entirely satisfactory. For details of these investigations, reference should be made to the Institute *Journal, Vol. 5, No. 2,* p. 176.

Further correspondence in relation to standards for a latex specification has taken place between the Institute and the London

Advisory Committee. It is hoped that a conference on the subject will be arranged during the leave of Dr. Rhodes in 1935. In the Institute, investigations on viscosity and dry rubber content of latex are being continued. It is proposed also to include tests on stability and any other tests which may be indicated as desirable and possible to carry out under estate conditions.

Alternative methods of preservation have been investigated and one or two promising products have been discovered, but it remains to be seen whether any of these will meet with the approval of consumers.

A list of proprietary and other products on which experiments have been carried out is given in the report of the Chemical Division. Both chemical and bacteriological investigations have indicated that the problem is not so simple as it might at first appear, since many fungicides and bactericides which are effective at low concentration in other media are ineffective when added to latex. A considerable amount of work has been done on this problem, as indicated in the reports of the Chemical and Pathological Divisions. Investigations have also been made on the putrefactive odour developing in preserved latex with a view to development of a suitable test for degree of putrefaction. A comprehensive investigation on the specific gravity of preserved latex has also been carried out and the results published in the Institute *Journal, Vol. 5, No. 3,* p. 234.

Latex Concentration

(a) *Creaming*

Investigations on the concentration of latex by creaming have been continued and it has been found that Tragon gum A, a product marketed by Imperial Chemical Industries, Ltd., is more reliable than gum tragacanth.

Further, it has been shown that many samples of so-called gum tragacanth marketed at home are useless as creaming agents. In addition, the necessity for creaming tests on freshly-preserved latex has been indicated by the comparison of results obtained on stored preserved latex in England and those obtained in Malaya on freshly-ammoniated latex.

Two new creaming agents are also under investigation.

One or two estates in Malaya are preparing and exporting creamed concentrated latex.

(b) *Centrifugal Concentration*

Unfortunately, owing to shortage of staff, investigations on the concentration of latex by centrifuging, in a new centrifuge

installed at the Institute towards the close of the year, have had to be postponed. It is hoped to operate this machine during the ensuing year. A large amount of this type of latex is exported by one plantation company.

(c) *Concentration by Evaporation*

Further investigations on concentration by spraying were carried out in London by the London Advisory Committee and the Rubber Growers' Association in collaboration with a Malayan Estate. The purchase of a plant may be considered at a later date.

Clone Rubber and Latex

During the year, the late Dr. Wiltshire commenced a comprehensive investigation on the properties of clone latex and rubber in order to determine any differences between the quality of latex and/or rubber from various clones and also to examine any seasonal variation or differences due to tapping methods. This investigation made considerable progress and the results to date were published in *Bulletin No. 5.* A detailed summary is also contained in the report of the Chemical Division. Although this work was cut short temporarily by the unfortunate death of Dr. Wiltshire at the end of the year, routine investigations are being continued, so that they can be analysed when the staff of the Chemical Division is again complete. It is intended to extend the scope of this work as additional clonal material becomes available on the Institute Experiment Station and elsewhere.

Coagulants

Formic acid continues to be the principal coagulant employed on estates in place of acetic acid, and its use is also increasing on small-holdings.

On a few estates, sulphuric acid is still employed for economic reasons, while investigations on small-holdings have shown that this acid is used fairly extensively in some districts. Considerable fear has however been aroused among some consumers of raw rubber as to the deleterious effect of this acid on the raw product. The India Rubber Manufacturers' Association of Great Britain has approached the London Advisory Committee on the subject and, as a result, an article containing the results of investigations on rubber from latex coagulated with this acid has been published in the Institute *Journal, Vol. 5, No. 3,* p. 282. It has been shown that if the acid is used in minimum quantity necessary for coagulation, it has no deleterious effect, while excessive amounts are not likely to be used, since this results in an unsatisfactory sheet.

Attention has however been drawn to manufacturers' requirements and prejudices in regard to this acid.

It is of interest to note that as a result of propaganda by the Rubber Instructors, the use of this acid by small-holders is decreasing.

Coagulants for Alkaline Latex

As a result of the preservation of latex with ammonia, and also of the accumulation of skim latex from the centrifuging or creaming of ammoniated latex, the search for a suitable coagulant for such latex is of importance, since acid coagulation is expensive and does not give satisfactory results. Investigations have shown that mixtures of magnesium chloride or sulphate with sodium silico-fluoride are satisfactory, although it is necessary to prepare a formula for different types or grades of such latex. These investigations are not yet complete but a preliminary paper has been published in the Institute *Journal, Vol. 5, No. 4*, p. 351. Since there appears to be some misapprehension as to the use of this coagulant mixture, it is desirable to state that it is not intended to use the coagulant for normal latex in place of formic or acetic acid, so that manufacturers need not be afraid of having to deal with another type of raw rubber prepared as a general procedure on estates. The alkaline latex used is in any case abnormal and produces an abnormal raw rubber whether coagulated by means of acids or by the coagulant mixture now recommended.

Preventatives of Mould on Rubber

Improved methods of preparation on estates, including better washing of sheet rubber, and the fact that rubber is not stored on estates for any length of time, has made the use of para-nitrophenol or other antiseptic substances practically non-existent.

At the request of certain manufacturers, conveyed through the London Advisory Committee for Rubber Research (Ceylon and Malaya), a warning has been issued against the use of para-nitrophenol in the preparation of pale crepe rubber. It has been pointed out that this chemical has not been used in Malaya as a mould preventative in the preparation of pale crepe. Mould attack, including the growth of various chromogenic organisms is however a frequent feature of the blanket crepe in the drying and storage rooms of the remilling factories in Singapore and Penang where the humidity conditions are favourable. In these circumstances soaking this blanket crepe in para-nitrophenol would be beneficial.

Manganese and Copper in raw Rubber

As a result of an enquiry addressed to the Institute by a large rubber manufacturing company in America complaining of the quality of a consignment of smoked sheet rubber from an estate in Malaya, in which, after storage for about two years, excess of manganese was discovered, investigations carried out by the Chemical Division of the Institute confirmed the presence of manganese. The manganese was traced to the use in the estate factory of a peculiar water supply containing a very high proportion of "total solids" and manganese and a high proportion of sulphuric acid. As a result of the recommendations made by the Institute, this water supply has been discarded.

It is of interest to record that such a water is exceptional in Malaya, since most Malayan river, well and spring waters contain a very low proportion of "total solids" and of mineral matter. Another interesting point in relation to this investigation is that the prolonged storage of the sheet rubber was responsible for the discovery of the manganese and its effects, since the action of manganese is slower than that of copper. Some portions of this rubber shewed no signs of "softening" or resinification, but the vulcanised product had very poor ageing qualities.

Investigations are being carried out in regard to possible copper contamination by the use of brass wire gauze in latex strainers. Apparently it has only recently been realised at home that brass wire gauze sieves are universally used for the straining of latex. Experiments are being carried out with other types of metal gauzes, although most of these are somewhat expensive.

It should be emphasised that in no case should ammoniated latex be strained through a brass wire gauze, since ammonia readily dissolves copper and would produce a latex having very poor ageing qualities.

Tackiness of crepe rubber due to copper was directly traced on one estate to portions of the wire gauze sieves embedded in the corrugations of the crepeing rolls.

Preparation of Sheet Rubber

Sheeting Batteries

The adoption of line-ahead sheeting batteries for increasing output has become general whenever new equipment is required and in many instances these batteries have been substituted for existing equipment. It has been found desirable to add an extra pair of rolls and to improve the grooves and estate names cut on marking machines in order to reduce the thickness of the sheet and thus effect more rapid drying.

These batteries have generally proved very satisfactory after the rolls have been properly adjusted to suit the coagulum and provided the tank coagulum is uniform in thickness and hardness. Most manufacturers of sheeting batteries for estate factories have adopted the new design.

Drying and Smoking

A drying and smoking cabinet, in which drying and smoking are separately controlled, has been designed by and experimented with by the Institute. It has, however, not yet been recommended for general use, owing to its comparatively high cost.

The separate drying and smoking chambers designed by the Socfin Co. have continued to give satisfactory service, if the sheet is sufficiently thin and uniform.

A number of "Subur" type single-storey smoke-houses have been erected on estates, as a result of recommendations made by the Institute. When the construction has been satisfactory this type of smoke-house has proved efficient and economical. In a few, however, several faults in construction have reduced the efficiency.

As a result of complaints from rubber manufacturers in Europe and America on the quality of light coloured sheet, in respect of ageing and plasticity, an investigation is being carried out. The results so far obtained show that hot-air-dried sheet has poor ageing qualities. Lightly-smoked sheet, which is dried too rapidly, will also probably be found to have poor ageing qualities. It may therefore be necessary to modify present recommendations in respect of the rapid drying and smoking of sheet rubber. The results of this investigation will be published shortly in the Institute *Journal*.

A circular on factory lay-out and smoke-houses has been prepared by the Chemical Division for issue to enquirers.

Packing of Rubber

Experimental shipments of sheet rubber in special paper sacks, *mengkuang* matting and treated hessian have been carried out by the Institute, while an estate has also despatched a large consignment of rubber in paper bags.

A local company will shortly be starting a sales campaign in connection with these paper sacks. While these are recommended by the Institute for reasons of economy, the question of containers or packing material is a matter for decision between producers and consumers.

Modified Rubbers

Rubber with low Water-Absorption

Owing to a demand for a raw rubber having low water-absorption properties, investigations have been commenced and are in progress with a view to preparing a suitable type of rubber to meet such requirements and also to ascertain to what particular factor low water-absorption can be attributed. This work is being carried out in conjunction with the London Advisory Committee. Details of some of the factors influencing the property are described in the Report of the Chemical Division.

De-odorized Rubber

For the manufacture of certain rubber articles such as wearing apparel, the peculiar odour of the material is considered objectionable. Investigations have been carried out by the consulting chemists of the Rubber Growers' Association and this Institute has collaborated in preparing types of raw rubber considered to be suitable for the purpose.

Soft Rubbers

As a result of the demand for a softer type of raw rubber, samples have been prepared by various methods, such as treatment with sodium nitrite, copper sulphate in small quantities to produce incipient oxidation, heating in steam, the addition of softeners etc.

Investigations carried out by the consulting chemists of the Rubber Growers' Association indicate that suitable paints can also be prepared by making modified rubber which is converted into a "resin". Samples prepared at the Institute have been despatched for experimental work on this problem.

Crumb and Powdered Rubbers

Considerable work has been carried out by the staff of the London Advisory Committee and also by manufacturers in the U.S.A. and Holland on the preparation of raw rubber in the form of a crumb or powder, and patents are in existence for the several methods in use. It is not yet possible to state the probable outlets of consumption for these products.

The Institute is collaborating with the London Advisory Committee in connection with this problem and also with one large manufacturing firm in the U.S.A. from which excellent samples of ordinary crumb and powdered rubber and samples of compounded crumb rubber have been received. If this rubber finds a suitable market for new uses such as the manufacture of linoleum products for flooring, a valuable new outlet will have been discovered.

General

Attention is drawn to the report of the London Advisory Committee and the technical appendix thereto, which contains more detailed reference to the investigations carried out in the laboratories of the Committee and the work in which this Institute has collaborated.

Rubber Roadways Research

As a result of the recommendations of the Commission of Enquiry on the work of the Institute, and subsequent correspondence with the London Advisory Committee, it has been decided to continue in the laboratories of the Committee in London the investigations in relation to the use of latex for rubber roadways, pavements, flooring, etc.

An annual grant for three years has been made from the funds of the Institute for this purpose. The Chemical Division of the Institute will continue to collaborate with the London Advisory Committee in meeting any requirements submitted or in carrying out any laboratory investigations which may be necessary in Malaya.

One side of the stretch of roadway laid by the Institute on the Kuala Lumpur—Port Swettenham Road in 1933 has continued to prove satisfactory. The other half has sunk in spots, but this is due in our opinion to failure of the cement foundation on this side.

The Kendall-Graham rubber carpet or sheeting laid down in Kuala Lumpur (in the vicinity of the Public Works Department offices) is wearing well. There are indications, however, that the attachment to the foundation is not perfect and that continuous heavy fast traffic would cause movement of the sheeting.

Several patches of the Cowling latex-cum-cement surfacing have had to be repaired, due to cracking and infiltration of water to the foundations. Most of this experimental stretch is, however, still in a satisfactory condition.

Experiment Station

During the year, the negotiations with the Forestry Department, F.M.S. & S.S., and the Selangor Government for an exchange of the reserve on the eastern side of the present planted area, which is mostly flat and which has a soil similar to the major portion of the planted area, for an area of more undulating land with a different type of soil, situated on the south-western bound-

ary, were completed. An area of 989 acres was relinquished and a new area of about 386 acres was acquired.

The survey of the new area has not yet been completed, but the total area now held by the Institute is about 1,332 acres, which includes approximately 894 acres planted.

New Planting and Nurseries

New plantings during the year include

(a) Block 26 (an area of about 11 acres, consisting of a portion of the elephant belt on the south-western boundary, between the planted area and the new reserve);
(b) Blocks 27—29 consisting of approximately 63 acres of new reserve;
(c) Blocks 1A and 16F comprising respectively 3 acres and 2½ acres, the former in the building site and the latter the site reserved originally for a factory site.

In addition a portion of the building site behind the Manager's bungalow has been planted as a nursery for budding. The old nursery of 5 acres in Block 12 has been eradicated and the budded nursery of 5 acres (Block 4) will be eradicated and converted into a new experimental block, after the transfer of the clone collection to the new nursery.

Manurial Experiments

The annual application of fertilizers in Block 6 has been continued. Tapping will commence on this Block early in 1935.

Catch-crop Experiments

The tapioca crop was not harvested during the year and this crop will be eradicated in 1935. Retardation of the growth of the rubber is noticeable on these plots. Similar areas on which coffee and pineapples are being grown as catch-crops showed also a retarding effect on the growth of the rubber, but not so marked as in the case of tapioca.

Cover Plants and Natural Covers

Records of growth of the trees on the various blocks on which different cover plants have been established, have been recorded and a further report will be published in the Institute *Journal* on the return from leave of the Senior Officer, Soils Division. Pronounced retardation of growth is observed on the plots on which natural undergrowth has been developed without any control or periodic slashing. The portion of this area however which

was completely cleared early in 1933 has since shown very vigorous growth and may eventually compare favourably with adjoining clean-weeded plots planted at the same time.

The new areas opened in Blocks 26—29 are being developed under various cultivated and natural cover plants with controls for a further study of this problem in relation to soil conservation and maintenance of fertility from the date of planting. Other experiments on the effect of grass and of digging-in grass periodically have been continued.

Pests and Diseases

Systematic work on root diseases and the control of white ants has been continued. The losses from root disease have shown a satisfactory decrease as a result of regular inspection and treatment.

A slight attack of *Oidium Heveae* occurred but was not sufficiently widespread or virulent to require treatment.

Budding

Supply budding was carried out where necessary, and budding of twin plants in Block 22. Various wound-dressing treatments for large stocks were tried and the results are given in the Report of the Botanical Division.

Tapping

Test-tapping was carried out on Blocks 2 and 4 on special seedling material.

Tapping will commence during 1935 on the Manurial Block (No. 6) and on the Clone Trial Block (No. 5)

General Upkeep

Weeding, upkeep of terraces, bunds and drains were all maintained in a satisfactory manner at a reasonable cost.

Buildings and Machinery

All buildings were maintained in good repair, while certain alterations were effected in the electric power and light plant and equipment which it is anticipated will render it less liable to damage by lightning. Work on new factory buildings will be commenced in 1935.

Health

The health of the Manager, Laboratory Assistants, Conductors and labour force has been excellent.

General

In addition to the details given in the Annual Report of the Manager, further records are included in the Reports of the Soils, Botanical and Pathological Divisions.

Conferences and Exhibitions

The staff of the Institute co-operated in the Annual Conference of the Incorporated Society of Planters and contributed papers as indicated in the Reports of the Divisions, and also took part in the discussions.

The Institute staged a comprehensive exhibit at the Annual Exhibition of the Malayan Agri-Horticultural Association held in Kuala Lumpur. This included a complete lay-out of a model estate factory for the preparation of sheet rubber, including a special drying-cum-smoking house designed at the Institute and constructed by the Federated Engineering Co., and a model sheeting battery designed and constructed by the same firm, together with model aluminium-lined tanks, bulking and settling tanks and chutes designed by Messrs. Diethelm & Co.

The exhibits also included various articles made direct from latex, articles illustrating new uses for rubber and various forms of latex and concentrated latex and powdered rubber.

In addition, the Botanical Division staged models and charts illustrating results of various systems of tapping and yields from budded rubber.

The Pathological Division staged exhibits illustrating Oidium leaf disease and its control by sulphur-dusting, including several types of dusting machines and also a comprehensive exhibit of specimens with narratives illustrating the three principal root diseases of the rubber tree and methods of control and treatment.

During the year the Institute was also asked by the Rubber Growers' Association, London, to collaborate in providing exhibits and photographs to illustrate the production side of the rubber industry in connection with a Rubber Exhibition to be held under the auspices of the Association at the Science Museum, South Kensington, London. The exhibits staged in our local Annual Agri-Horticultural Exhibition were used as a nucleus for the exhibits sent to London. The Exhibition in London was opened in November and continued till the end of April 1935. Letters received from various authorities indicate that the exhibits from the Institute were much appreciated and constituted a very valuable part of the exhibition.

The Rubber Growers' Association and other Institutions have asked to be allowed to retain the exhibits for future use. It is possible also that the exhibition may be transferred to other provincial centres.

Lectures

The following lectures were given by members of the staff:—

Subject	*Venue*	*Lecturer*
New Methods of Root Disease Control and their Application	I.S.P. Annual Conference	R.P.N. Napper
Tapping Systems	—do—	C.C.T. Sharp
Recent Investigations on Latex	—do—	E. Rhodes
Forestry Methods of Cultivation	I.S.P. Taiping Branch	C.G. Akhurst
—do—	Central Perak Planters' Association	—do—
—do—	I.S.P. Bahau Branch	—do—
Natural Covers	Central Pahang Planters' Association	—do—
—do—	I.S.P. Nilai Branch	—do—
Sulphur Dusting	I.S.P. Rantau—Port Dickson Branch	A. Moore
Present Methods of Rubber Manufacture and Packing	I.S.P. Kuala Selangor Branch	R.O. Bishop
The Drying of Rubber	I.S.P. Nilai - Labu Branch	—do—
New Root Disease Theory	I.S.P. Taiping Branch	R.P.N. Napper
—do—	I.S.P. Tampin-Jasin Branch	—do—
—do—	Central Perak Planters' Association	—do—
Oidium Heveae	I.S.P. Tampin-Jasin Branch	F. Beeley
—do—	I.S.P. Kuala Lumpur	—do—

At the Third Imperial Mycological Conference held in London from the 17th to 22nd September, 1934, Mr. A. Sharples, formerly Head of the Pathological Division, represented the Institute in an honorary capacity.

Publications and Library

The publications issued during the year include the following:—

(i) *Journal* Vol. 5, Nos. 2, 3 and 4.
(ii) *Bulletin No. 5.* Variations in the Composition of Latex from Clone and Seedling Rubber.
(iii) *Planting Manual No. 5.* The History and Description of Clones of *Hevea Brasiliensis:* Supplementary Sheet No. 1.
(iv) *Planting Manual No. 6.* The Uses and Control of Natural Undergrowth on Rubber Estates.
(v) *Annual Report 1933.*

In addition to these publications, circulars have been prepared and replicated for issue to enquirers on a number of problems relating to estate practice such as specific diseases and pests, lay-out of factories and design of smoke-houses.

On the resignation of the Librarian on the expiration of her leave, it was decided that the duties should be carried out by the Secretary and this arrangement having proved satisfactory has been continued to date. A library clerk assists the Secretary in this work.

The card index of all important articles in the technical journals received on rubber and other agricultural and technical problems which might have a bearing on our work, has been maintained.

Translations of several articles from the Dutch have been made by a translator at arranged fees.

Visitors

As in previous years, a large number of planters and others, including a number from outside Malaya have visited the Institute and the Experiment Station.

A conducted tour of the members of the Geographical Club of the Raffles College, Singapore, and conducted tours of members of several branches of the Incorporated Society of Planters, and students of the School of Agriculture, Malaya, were made.

Special visitors included the following:—

Sir John Barlow, Bart., Dr. d'Angremond (Director, A.V.R.O.S. Proefstation, Sumatra), Dr. de Jong (Holland American Plantations, Sumatra), Mr. Gaskell (Imperial Chemical Industries Ltd., London), Dr. P. J. S. Cramer, Mr. Kelly (Goodrich Rubber Co., Akron, U.S.A.), Mr. Planchon (Michelin et cie, Indo China), Mr. Bicknell (Holland American Plantations, Sumatra), Kwai Fan Koo and Chong Yoh Taam (Bureau of Agriculture and Forestry, Canton), Prof. Choji Ito (Economist and Geographer, Kyushu Imperial University, Fukuoka), Dr. Samuels (Plant Pathologist, Rothamsted Experiment Station), Dr. W. B. Wiegand (Binney & Smith, U.S.A.), Mr. Butler, (Canadian Trade Commissioner, Singapore), Dr. Wishart (University of Cambridge), Tsuimitoru Koto (Bureau of Natural Resources, Japan).

General

In spite of shortage of staff and much advisory correspondence good progress has been made in a number of directions during the year and in this connection acknowledgment is made of the loyal co-operation of all members of the staff, many of whom have been considerably over-worked.

Unfortunately it will not be possible to fill existing vacancies until the second half of 1935.

Acknowledgment is also made of the valuable help of managers of estates who have co-operated with us in various directions in connection especially with field experiments on estates which are essential for broadening the basis of our investigations.

Acknowledgment is also made of the valuable advice and work of Mr. D. S. Gardner who was responsible first as Manager for opening up the Experiment Station and subsequently as Visiting Agent.

B. J. Eaton

Director

Kuala Lumpur

13th July, 1935

APPENDIX

Soils Division

Analysis of Correspondence

Subject	Letters received	Letters despatched
Cultivation—General Enquiries ...	13	15
—Forestry Methods ...	30	39
—Experiments	46	62
Cover Crops and Natural Covers:		
—General Enquiries ...	102	116
—Manuring	7	8
—Eradication by Weed Killers	28	29
—Seeds	16	21
Manuring	106	114
Soil Conservation	10	11
Catch Crops	5	5
Replanting	52	66
Visits	33	65
Fertilizers	15	18
Soil Samples	51	57
Miscellaneous	14	25
Total ...	528	651

BOTANICAL DIVISION

Analysis of Correspondence

	Subject	Letters received	Letters despatched
I. Budding.	General. Advice on		
„	choice of clones. Clone Records	195	217
„	Training of Conductors and Pupils from Estates, etc.	5	6
„	Field Experiments (Estate Trials) ...	6	6
„	Growth of Budded Trees	14	12
„	Purchases & Exchanges of Budwood ...	11	12
		231	253
II. Tapping.	Estate Enquiries General	95	100
„	Estate Experiments General	51	42
„	Estate Enquiries (Tapping of Budded Trees)	43	40
„	Estate Experiments (Tapping of Budded Trees)	122	116
		311	298
III. Selection.	Individual Mother Trees; selection on estates	2	3
„	Seed selection ...	1	2
„	Latex Vessel and Bark Examinations ...	3	3
„	Isolation Gardens ...	6	7
„	Seeds for Experimental purposes	8	8
„	Requests for seeds ...	6	8
„	Type samples of seeds of proved clones ...	10	16
		36	47

Subject		Letters received	Letters despatched
IV. General.	Planting Enquiries ...		
	Information on planting Operations ...	6	6
	„ Replanting ...	22	23
	„ Cover Plants ...	61	70
	„ Rubber-producing plants other than Hevea	1	1
		90	100
V.	Special Enquiries in connection with Rubber Assessment ...	25	30
VI.	Apparatus	8	10
VII.	Miscellaneous	1	5
	Grand Total ...	702	743

Pathological Division

Analysis of Correspondence

Subject	Letters received	Letters despatched
Root Disease	114	184
Stem & Bark Disease	82	93
Leaf Disease	187	197
Fungicides & Insecticides	61	61
Tree Operations	7	9
Injury by external Agents	1	1
Insect Pests	31	38
Brown Bast	21	26
Spraying & Dusting Equipments ...	22	46
Pathology of Buddings	3	3
Disease—General Treatment	17	24
Replanting	16	20
Lightning	1	1
White Ant treatment	19	25
Sulphur Dusting	22	24
Miscellaneous	33	48
Total ...	637	800

Chemical Division

Analysis of Correspondence

Subject	Letters received	Letters despatched
Latex	29	48
Latex Preservation	203	231
Latex Concentration	89	105
Latex—Instruments for determining D.R.C.	98	128
Anti-coagulants of Latex	16	17
Anti-oxidants of Latex	3	4
Rubber Preparation—General	78	102
Coagulants	101	130
Coagulating Tanks and Pans	26	27
Smoked Sheet	102	112
Smoke-Houses	103	168
Air-dried Sheet	28	36
Crepe Rubber	33	44
Crepe Rubber—Lower Grades	16	10
Sole Crepe	22	22
Raw Rubber Powder	18	28
Water Samples	6	16
Machinery for Rubber Manufacture ...	112	172
Vulcanisation of Rubber	47	65
Vulcanising Machinery & Apparatus ...	3	2
Accelerators for Vulcanisation ...	6	6
Rubber Softening Agents	12	14
New Uses of Rubber	51	66
Rubber Substitutes	1	1
Rubber Paving for Road Surfacing ...	26	45
Rubber Paints	4	7
Rubber Seed Oil	1	1
Rubber Oil	3	2
Patents	49	60
Use of Rubber for Pipe Liners ...	1	1
Quebrachitol	8	8
Orders for Chemicals, etc	20	34
Miscellaneous	14	20
Total ...	1,329	1,732

Interviews	268
Visits paid to Estates	49

ANNUAL REPORT

SOILS DIVISION

Staff

The work of the Division was hampered during the year owing to members of the staff being on leave. In February, the Head of the Division proceeded on long leave and the writer, who was appointed to act for him, was the only European officer in the Division for the remainder of the year. In addition, Mr. K. S. Pillay, Assistant Soils Chemist, was on leave from 20th July to 30th November. The work of the Division suffered in consequence, resulting in a reduction in the amount of analytical routine work, while it was not possible to carry out any laboratory research work. Advisory work was carried on at the normal rate, although fewer visits were made to estates.

Throughout the year, however, close contact was maintained with the various experimental areas on estates, and steady progress was made, particularly in connection with replanting experiments and with those dealing with the cultivation of natural covers.

Routine Laboratory Work

The following figures, comparing the year under review with previous years, indicates the reduction in analytical work:

		1931	1932	1933	1934
Samples received	...	369	336	368	304
Analytical determinations	...	2742	3473	3770	2138

Thus, the number of samples received was less by about 17 per cent and the total number of analyses carried out on these samples was lower by about 43 per cent, compared with 1933.

Summary of Determinations (Soil Analyses)

Loss on evaporation	...	...	...	16
Loss on ignition	...	...	...	145
Mechanical analysis	...	...	...	145
Exchangeable bases	...	...	...	250
Water soluble matter	...	...	...	4
Electrometric *p*H	...	...	...	240

Colorimetric *p*H	...	...	...	246
Carbon	...	...	...	420
Nitrogen	...	...	...	420
Potassium	...	...	...	100
Phosphate	...	...	...	104
Calcium	...	...	...	48
Total number of determinations				2138

The 304 samples examined include 300 samples of soils, and 4 samples of fertilisers.

About 100 of the samples were routine samples taken from the Government Coconut Plantation, Klang, and the Central Experiment Station, Serdang, where, by arrangement with the Department of Agriculture, systematic observations are being made on certain areas under lalang.

Advisory Work

The pressure of advisory work was well maintained throughout the year and fully occupied the time of the European staff of the Division.

Correspondence

The number of letters sent out was even larger than in the previous year, being 691, an increase of nearly 50; the detailed analysis of the subjects dealt with is appended to the Director's report.

Visits

The total number of visits paid to estates and experimental areas was 107, fewer than last year, but well above the number paid in 1932. It was not convenient, owing to lack of staff, to arrange extensive tours lasting a week or longer, as has been done in previous years, but short visits, lasting two or three days, were made on several occasions by the Acting Senior Officer of the Division to Perak, Johore and Negri Sembilan.

In addition, 60 interviews were accorded to visitors to the laboratory, at which useful and interesting discussions arose.

Natural Covers

The encouragement of natural covers on estates is a practice which is still growing, and there are no signs yet that this policy

is likely to be changed. The publication during the year of *Planting Manual No. 6*, "Uses and Control of Natural Undergrowth on Rubber Estates", by W. B. Haines, proved to be a much appreciated addition to the literature on this subject, particularly the appendix of drawings of typical plant growths.

It is now becoming more widely realised that the cultivation of natural covers cannot be rigidly defined by lists of good plants and bad plants, but that each individual estate must be treated on its own merits and that different fields or areas on the one estate may require to be examined separately. Also, the selection of plants which it is desirable to retain must be made at present on the general characteristics of habit of growth, nature of tissues, root system and feeding habits.

On most estates which have encouraged the growth of natural covers during recent years there has been considerable progress made during the last twelve months towards the ideal type of conditions, but in no instance yet observed has a state of balance and equilibrium been attained in which the plants may be said to have reached a climax type.

Weed Killers

Several experiments, carried out during the past year on various estates by the managers, have produced fairly clear indications of the value of certain types of weedicides, which can be applied as liquid sprays for controlling strong growths of natural covers. The results are being published in the *Journal* of the Institute, and may be briefly summarised as follows.

Only two types of chemicals have been tried extensively—sodium chlorate, in aqueous solutions, and an arsenical spray (sodium arsenite in alkaline solution). Lalang and other grasses cannot be killed by spraying, except at great expense, although their growth can be checked effectively by the killing of the above-ground material. Bush types of covers usually only suffer leaf-scorching when sprayed. Bracken and stagmoss, under suitable conditions, can be effectively killed at a cost of about $3.00 per acre.

No harm from either spray is done to the soil or to the rubber trees, since comparatively dilute solutions are used. There is one definite advantage in spraying methods to eradicate undesirable natural covers, *viz.*, that no digging and loosening of the soil is involved, which would increase erosion losses, and no cutting of rubber tree roots, as when a *changkol* (heavy hoe) is used.

The use of sprays in this country is, however, distinctly limited, owing to the dampness of the climate and the frequency of rain storms. Spraying can only be successful in spells of dry

weather, and during only a few periods in the year can even short spells without rain be expected with certainty.

Manuring

A gradually increasing interest in manuring has become apparent this year, coinciding with the improved financial position, and the new manuring programmes are concerned chiefly with treating areas of moderately good mature rubber which are just beginning to show signs of deterioration in the trees as indicated by the foliage. Such propositions are very likely to yield successful results, since the object of applying artificial fertilisers is to maintain the condition and present yields of the trees, and not necessarily to increase their yields.

Contact with the older manuring experiments has been maintained and will be continued.

Replanting

Attention to replanting of old and uneconomic areas on estates has been focussed by the advent of the present Rubber Regulation Scheme, which forbids any new planting for the next five years; in the latter half of the year numerous estates embarked on programmes.

The total amount of replanting is limited, for the duration of the Scheme, to 20 per cent of the previously planted area, but at present it appears a little uncertain as to what effect this replanting, if done, will have on the official quota granted to an estate. It has become apparent from our experience that, if no loss of quota is involved when replanting is undertaken, the number of estates willing to embark on such programmes will be greatly increased and this will be a deciding factor in the course of artificial fertiliser absorption in this country.

Results from several experimental replantings, over their first year or two, have become available, and the conclusion is that, with suitable manuring, satisfactory growth for the first and second year can be attained on soils of only poor to fair fertility, although this does not necessarily predict equally good growth in future years on such areas.

The loss of crop which will occur during the years before the new stand is tappable can usually be appreciably reduced by a system of drastic tapping of the old trees before cutting out, and by this means a yield equal to one or two years' normal crop might be obtained in six or eight months of "tapping to death".

Field Work

Experiment Station

Two series of growth measurements were taken during the year and have been prepared for publication in the *Journal*.

The trees in Block 6, which is an area under a manuring experiment, still show only very slight difference between the manuring treatments and, in so far as growth is concerned, it appears that on this particular virgin soil the trees can grow at their maximum rate without the aid of fertilisers. Possibly effects due to the fertilisers may show up in the yield of the latex when the trees are tapped. Tapping will be commenced in this Block in 1935.

Experiments started in the last two years on the effects of grasses and natural covers on the growth of the rubber (Blocks 19 and 25) are progressing steadily, and will link up with the other experiments using leguminous covers and natural covers which are in progress (Blocks 7 and 8, 11 and 17).

Other work on the experimental blocks has continued according to programme and is fully reported in the *Journal*; plans have been made for laying down a manuring experiment on budded rubber.

Cultivation Experiments

Most of these experiments have completed their first year of treatment, and measurements of growth and yield are being recorded where it is suitable to do so. It is not, however, of value to attempt yet to draw conclusions from the data available.

Lake Gardens (Kuala Lumpur) Experimental Area

The natural covers which are being encouraged in this area grew strongly during the year, and control was maintained by a slashing round in July. Stagmoss, bracken and lalang are eliminated wherever they appear, but Singapore rhododendron is still allowed to grow. More desirable covers are increasing in numbers, but no effects have yet appeared in the rubber trees.

Specimens of typical and common natural covers are being planted in special plots, and these are accumulating with the addition of new plants received from time to time from estates.

Lectures

Four lectures were given during the year by the Acting Senior Officer of the Division, all of which dealt with the development and control of natural covers.

Title of Lecture	*Venue*
"Forestry Methods"	Incorporated Society of Planters, Taiping Branch, Taiping.
.. ..	Incorporated Society of Planters, Bahau Branch, Bahau.
"Cultivation of Natural Covers"	Incorporated Society of Planters, Nilai Branch, Nilai.
"Forestry Methods"	Central Pahang Planters' Association, Bentong.

Publications

The following publications have been prepared during the year:

Planting Manual, No. 6, "The Uses and Control of Natural Undergrowth on Rubber Estates" by W. B. Haines.

In press — "Use of Weedkillers in controlling Natural Covers" by C. G. Akhurst.

"Effect of Covers and Cultivation Methods on the Growth of Young Rubber. (V)" by C. G. Akhurst.

Summary of Rainfall at the Experiment Station

	Inches		
	1932	*1933*	*1934*
January	4.92	6.06	11.01
February	8.98	6.69	5.85
March	10.51	19.17	13.36
April	6.19	16.35	12.01
May	8.67	9.41	4.55
June	2.40	2.76	6.05
July	2.77	4.62	5.62
August	12.73	4.65	7.63
September	8.31	10.16	9.56
October	17.29	6.56	10.00
November	11.76	11.40	15.82
December	12.74	14.75	3.35
Total ...	107.27	112.58	104.81

C. G. Akhurst

Acting Senior Officer, Soils Division

January, 1935

ANNUAL REPORT

BOTANICAL DIVISION

The year under review has been marked by steady progress of the investigations the initiation of which has been described in the Annual Reports of previous years. There have been no major alterations in the general programme of research but important extensions have been made to the work in certain directions.

In particular, the work on selection and breeding calls for special mention. During the lean years, when it became necessary to review the aims and progress of researches on the problems of the rubber plantation industry, as a result of strong opposition to further expenditure on so-called production research, it was decided to curtail the development of research work which had as its chief aim the improvement of planting material of Hevea. In breeding investigations with a perennial tree crop such as Hevea, progress is necessarily slow. The work accomplished before the decision to curtail further development was taken has just now reached the stage when the first results of general interest to the planting industry are forthcoming. It is therefore extremely interesting to record that there is hardly any other subject of investigation in the Botanical Division which has aroused more interest during the latter half of the year 1934 than the progress of work on breeding and selection of high-yielding seedling trees. The introduction of the International Scheme for the Regulation of Rubber Production is no doubt responsible, at least in part, for the change in viewpoint. Furthermore, there is a considerable body of conservative opinion particularly in Malaya, which is possibly prejudiced but is certainly distrustful of the claims made for the success of methods of vegetative propagation of rubber. Those who, in spite of evidence sufficiently strong to dispel all reasonable doubts regarding the ultimate commercial success of budding methods, adhere to their preference for other means of raising the standard of production, welcome any evidence which supports their faith in the ultimate superiority of the "natural seedling tree". Under the existing regulations the provisions for replanting of uneconomic areas have resulted in renewed interest in superior planting material and in this connection the progress of work on seedling trees, developed by means of the careful application of methods of selection and breeding from proved high-yielding parents, is arousing the keenest interest. It is not intended to discuss here the relative merits of different types of planting material, and the

present position has been outlined mainly to illustrate the difficulties with which the investigator may be faced when a carefully-planned scheme of investigations is liable to be subjected to radical modification in sympathy with sudden economic changes. It is perhaps fortunate that, in breeding investigations with Hevea, although active extension of the work may be suspended for a period, the results of earlier work are not lost entirely. The trees remain although the continuity of the work may be interrupted.

Staff

The staff of the Division has remained the same as in 1933. Mr. C. C. T. Sharp left for England on leave at the end of October. Mr. K. N. Kaimal was absent on leave from February to July.

Reports of Investigations in Progress

The form of presentation of progress of investigations is the same as that employed in previous years in order to facilitate reference.

I. Vegetative Propagation

(1) Technique of Budding Operations

No new experiments have been carried out. The methods now in general use appear quite satisfactory for all types of material and little further experimental work is necessary.

C. E. T. M.

(2) After-care of Budded Trees

Investigations on the treatment of pruning cuts, particularly treatment of the snag surface on large stocks have been continued. Previous experiments having demonstrated the unsuitability of black dressing, *e.g.* asphalt-kerosene, various brands of tar, and preparations containing wax, tests with different materials have been initiated; full details will be published in 1936. The most promising results so far have been obtained with the application of a clay paste containing cattle manure, protected by a covering of coarse hessian.

C. C. T. S.

(3) Vegetative Propagation of Stocks

With seedlings and young buddings of certain clones a combination of layering and ringing followed by

earthing-up has given promising results. Free root formation has occurred above the rings on layered shoots. As soon as the root systems appear to be sufficiently well developed the successful layers will be transplanted to the field for further study.

C. E. T. M.

(4) Studies of the Growth of Budded Trees

(a) *Comparison of the Growth of Buddings of different Clones under uniform Conditions on virgin Soil (R.R.I. Exp. Sta. Block 5)*

In continuation of previous reports* the progress of growth of budded trees of a number of well-known proved clones is shown in Table I. Clones Pilmoor B 84, Prang Besar 186 and Tjirandji 1 appear to be outstanding in vigour. These clones are finding favour in replanting operations. Clone B.D. 5 is exceptional in its habit of growth. Even on the most fertile soils, under very favourable conditions, the growth of buddings of this clone is generally backward for the first 3 to 5 years. Crown formation is very slow and the clone is very sensitive to dry conditions, and 'winters' at the least suggestion of drought. Wintering is followed by prolific shooting of

Table I. *Growth of Buddings under uniform Conditions; age 4 to 5 years, planted as budded Stumps November 1929*

Plot Index	Clone	Mean girth in inches at height of 20 inches from Union		
		Nov. 1933	Nov. 1934	Increase 4th-5th year
A	A.V.R.O.S. 152	12.6	16.3	3.9
B	„ 49	13.2	16.7	3.5
C	Prang Besar 23	11.7	15.7	4.0
D	„ „ 186	14.1	17.8	3.7
E	Bodjong Datar 5	10.2	13.4	3.2
F	Tjirandji 1	13.5	17.6	4.1
G	Pilmoor A 44	12.3	16.5	4.2
H	„ B 84	14.4	18.8	4.4
J	A.V.R.O.S. 50	12.5	16.7	4.2
	Mean of all clones	12.7	16.6	3.9

**Annual Report R.R.I. of Malaya* (1929) 54; (1930) 59; (1931) 54; (1932) 59; (1933)' 68.

lateral buds and the production of dwarf branches. The majority of the dwarf branches die off naturally, a few continue to grow vigorously and form a well-shaped and strong branching system. Once the lateral branch system is well established the rate of growth and girth increase improves rapidly.

The growth records summarised in Table I are from buddings made on 10 to 12 months-old-stocks in nursery beds and transplanted to the field. If the rate of growth during 1934 is maintained during 1935 the average girth in November 1935 should be approximately 21 inches. This is slightly above the standard girth required for the commencement of commercial tapping. Trees of the most vigorous clones, Pilmoor B 84, Prang Besar 186 and Tjirandji 1, will reach tappable size in about 5½ years from the date of planting as budded stumps.

C. E. T. M.

(b) *Comparison of the Growth of Buddings of different Clones on a replanted Area (R.R.I. Experiment on an Estate)*

The study of growth of buddings on a replanted area where the soil is similar in geological origin to that on the

TABLE II. *Rate of Growth of budded Trees on virgin and replanted Areas; age of trees 4 years*

A. Planted as budded Stumps October 1930
B. Planted as budded Stumps November 1929

	Clone	Mean Girth in inches at height of 20 inches from Union			
		A. Replanted Area	**B.** Virgin Soil	Ratio:— $\frac{B}{A}$	
				4th year	3rd year
A	A.V.R.O.S. 49	8.7	13.2	1.5	1.7
B	A.V.R.O.S. 50	9.2	12.5	1.3	1.6
C	Bodjong Datar 5	8.4	10.2	1.2	1.4
D	Tjirandji 1	9.6	13.5	1.4	1.8
E	Pilmoor B 84	9.2	14.4	1.4	2.0
F	Glenshiel 1	8.9	—	—	—
	Mean of Clones A to E	9.0	12.8	1.4	1.7

R.R.I. Experiment Station has been continued.* In view of the slow rate of development observed during the first three years, manuring and cultivation treatments have been introduced during 1933 and 1934. The comparative rates of growth on virgin and replanted soils are shown in the summary of growth records in Table II. The experimental area was planted with budded stumps in October 1930.

There has been a general improvement in growth in this area as shown by the marked decrease in the value of the ratio B/A given in Table II. It is interesting to note that Clones Tjirandji 1 and Pilmoor B 84 are particularly vigorous in both areas.

Manuring and cultivation operations have been in part responsible for the observed improvement. The treat-

TABLE III. *Effects of certain manuring and cultivation Treatments on Growth of budded Trees in a replanted Area*

Summary of Treatments		Tree Girth in inches at 20 inches from union		
Half plots 1933	Quarter plots 1934	February 1934	December 1934	Increase expressed as a percentage
Covers turned in between rows- July 1933	1 lb. Sulphate of ammonia per tree Jan. 1934	5.8	8.5	46.6
	1 lb. Sulphate of ammonia ½ lb. Sulphate of potash Jan. 1934	5.9	8.6	45.7
July 1933 Manured, no special cultivation	1 lb. Sulphate of ammonia Jan. 1934	6.2	9.3	50.0
2 lb. Rock phosphate 1 lb. Sulphate of ammonia per tree	1 lb. Sulphate of ammonia ½ lb. Sulphate of potash Jan. 1934	6.1	9.3	52.4

**Annual Report R.R.I. of Malaya* (1930) 62; (1931) 57; (1932) 60; (1933) 69.

ments given and their effects on growth are summarised above.

The growth records summarised above indicate that the manuring with nitrogen and phosphates in July 1933 had a more beneficial effect than the digging-in of cover plants. The beneficial effect of extra applications of potash in January 1934 is not apparent so far.

C. E. T. M.

(c) *Comparison of the Growth and Development of proved Clones under different Conditions on Estates*

The examination of records of growth of budded trees of the well-known proved clones established on estates has been continued and the results obtained during 1934 confirm those recorded in some detail in the report for 1933*. The influence of different environmental conditions on the growth of different clones may be very marked; on the other hand certain clones, *e.g.* A.V.R.O.S. 49 and Prang Besar 186 show remarkably uniform development on very different soil types. The information compiled so far enables us to make general recommendations regarding the choice of clones for different soil types. Thus, for alluvial soils of the coastal areas, Clones A.V.R.O.S. 49 and 50, Bodjong Datar 5, Prang Besar 25 and 186, Pilmoor D 65, Rubana 393 and Sabrang 24 are recommended. For the quartzite-loam soils intermediate between the coast belt and the inland hilly estates, Clones Prang Besar 86, 180 and 186, Tjirandji 1, Glenshiel 1, Pilmoor B 84 and A.V.R.O.S. 49, 152 and 256 appear to be most satisfactory. Clone B.D. 5 may also be included here but on sandy soils this clone shows poor early growth. For hilly areas where the soil is generally lateritic, the clones which are satisfactory on the quartzite-loam soils generally thrive well but it is advisable to avoid the use of such clones as Tjirandji 1, A.V.R.O.S. 152 and to a lesser extent Prang Besar 25 as these clones are susceptible to storm damage and, when planted in exposed situations, serious losses may occur.

C. C. T. S. and C. E. T. M.

(d) *Influence of Density of Planting on Growth and later Development of budded Areas (R.R.I. Exp. Sta. Block 14 C & D)*

**Annual Report R.R.I. of Malaya* (1933) 70-72.

Observations and growth measurements have been continued on the density-of-planting experiments commenced in December 1930. A summary of the main results is presented in Table IV.

TABLE IV. *Comparison of the Growth of Buddings of Clone A.V.R.O.S. 50 at different planting Densities*

Plot Index	Planting Distance feet	No. of Trees per Plot	Mean Girth per Tree in inches		
			December 1933 Age 3 years	December 1934 Age 4 years	Increase
A	30 x 30	54	8.0	12.1	4.1
B	20 x 20	117	8.3	12.1	3.8
C	14 x 14	247	7.8	11.5	3.7
D	12 x 12	320	8.2	11.7	3.5
E	10 x 10	468	8.1	11.1	3.0
F	20 "triangular"	125	8.2	12.1	3.9

The retarding effect of overcrowding on growth is now becoming apparent but it will be noted that the maximum difference in girth is only 1 inch on a mean tree-girth for the whole area of 11.8 inches.

In preparing the experimental area, which consists of 36 plots, six plots at each density of planting, half of the plots were cleared of all surface timber and jungle stumps, and on the other half stumps and timber remained to decay *in situ*. The average girth of the trees in the cleared plots is 11.6 inches whilst in the uncleared plots the figure is 12.0 inches. The difference is just significant.

In an independent experiment (see notes under (a) above) Clone A.V.R.O.S. 50 was included in a general comparative test of nine different clones in which the distance of planting was 20 feet by 20 feet. At the age of four years the buddings showed a mean girth of 12.5 inches as compared with 12.1 inches in the 20 ft. × 20 ft. plots in the present experiment. In both experimental areas planting was with budded stumps from nurseries. Considering the possible influence of differences in seasons during the periods 1929 to 1933 and 1930 to 1934, the agreement in rate of growth is very close. It may be mentioned that Clone A.V.R.O.S. 50 was chosen for use as a 'control' clone for comparative work on all experimental plots where new material is under test.

(5) The Mutual Relationship between Scion and Stock in Buddings

(a) *Influence of Stock Vigour on Growth of Scion*

Observations have been continued on this subject but there will be little further to report until the buddings under observation reach the tapping stage. Study of the growth of buddings made on stocks of different ages up to three years shows that, although the early growth of scions budded on the older strong stocks may be much more vigorous than that of scions budded on normal one-year-old stocks during the first year, there appears to be a check in growth during the second year from budding in the case of buddings made on large stocks. The growth of buddings on the smaller and younger stocks does not show this check, so that at two years from the date of budding the scions may show almost equal development with those made on larger stocks. The check in growth may be connected with the process of "snag healing", which may take a considerable time when buddings are made on very large stocks. Possibly when the union is complete the growth of the buddings made on these large stocks will again exceed that of buddings made on the smaller and younger stocks. Further study is required to determine this.

C. E. T. M.

(b) *Influence of Scion on Yield of Stock*

(i) The experiments described in previous reports in which methods of high budding and budding of twin seedlings have been employed to provide material for the study of this problem have not yet reached the tapping stage.

(ii) The budding of a large-scale field experiment on twin seedlings on R.R.I. Experiment Station Block 22B (10 acres) was completed during the year. Twin seedlings from illegitimate seed of Clones Prang Besar 20 and 24, Sungei Reko 9, Pilmoor A 44 and mixed clones have been budded with Clones Prang Besar 186, Pilmoor B 84 and A.V.R.O.S. 50.

(iii) A preliminary tapping experiment initiated in November 1933 on high buddings of Clone Tjirandji 1, budded on seedling stocks three years of age, has been continued.

(c) *Use of special Stocks for budding*

(i) In the isolated seed gardens budded trees of *Hevea spruceana* in pure planting and *Hevea spruceana* interplanted with *Hevea brasiliensis*, flowered for the first time in December 1934. It is hoped to obtain sufficient seed during 1935 to commence experiments on the value of "foreign" stocks for use in budding with *Hevea brasiliensis*.

(ii) Seedling stocks derived from the seed of different well-known clones have been planted in permanent plots for field tests of their possible value in budding work.

These studies, which are incidental to those referred to in (b) above, have been discontinued for the time being. They will be resumed when tapping tests are commenced on the material now established on the Experiment Station when the study of yield and the study of structure can proceed together.

C. E. T. M. and K. N. K.

II. The Physiology of *Hevea brasiliensis* in relation to Latex Production

Under this general title all experimental work on the tapping of seedlings and budded trees is included. Work on the structure of the tree in relation to latex production also forms an integral part of the studies on the same general problem. The immediate object of these investigations is the improvement of the older tapping methods and the study of the new methods of tapping to be employed on budded trees. Since it is impossible to classify botanical investigations on Hevea into clearly defined categories, references to tapping experiments occur in other sections of this report as, for example, in the work on breeding and selection. In such instances, tapping tests are applied in order to obtain information concerning the material tapped. In the studies described in the present section the material is used to provide information concerning the tapping system and the manner in which latex is produced by the tree in response to different tapping methods.

(1) Tapping Experiments on mature Trees grown from Seed

(a) *Experimental work in the Lake Gardens Area (30 acres)*

As stated in the *Annual Report* for 1933 the uniformity test, normal alternate-day tapping over the whole area,

showed that owing to the wide variations in yield and previous treatment of the trees the area was not suitable for the experimental work in view. During 1934 tapping has been continued on the same system as in 1933 in order to provide yield data for the various plots for use in connection with regeneration studies which are being being carried out by the Soils Division.

Apart from this general routine work there is one experiment of particular interest. Adjoining Plot A is a small area planted at the same time as 'A' but which appears to have been included in a building or road reserve before the trees reached the tapping stage. The trees are at least 20 years of age and at the time of their "re-discovery" in April 1933, were growing under secondary jungle conditions and had never been tapped. Undergrowth was cleared sufficiently to provide tapping paths and tapping was commenced in April 1933. Odd-numbered trees were tapped with the 'V' cut (so popular in Malaya) and even-numbered trees were tapped on the half-circumference left-to-right spiral cut. The results are summarised in Table VI.

TABLE VI. *Comparison of Yields of Mature Trees tapped alternate-daily with single spiral and 'V' cuts*

Tapping System	No. of Trees	Mean Girth at 20"	Yield			
			1933		1934	
			Pounds per Tree	Per cent	Pounds per Tree	Per cent
Single Spiral cut on half-circumference	32	46.0	22.3	100	19.3	100
'V' Cut on half-circumference	32	43.1	17.8	80.0	15.7	81.3

The records indicate that trees which have been allowed to grow to maturity without disturbance from cultivation or tapping may be capable of very much higher yields than are usually obtained in a normal commercial plantation. There is every indication that the half spiral

cut is considerably more productive than the 'V' cut during the early years of tapping.

C. E. T. M.

(b) *Investigation of Economic Tapping Systems*
Experiments on Seventh Mile Estate, Kuala Lumpur

In continuation of the progress reports given in the *Annual Report* for 1933* and the full account of the first year's results published in the *Journal*† the results obtained during the first six months of the second year of the investigation are summarised below in Table VII.

TABLE VII. *Tapping Experiments on Seventh Mile Estate*

Tapping System	Period		Yield of First grade rubber		Yield of Scrap		Total Yield of Rubber	
	Tapping months	Rest months	lb.	Per Cent of Control	lb.	Per cent of No. 1	lb.	Per cent of Control
1. ABC.	6	3	245.1	85.0	21.7	8.9	266.8	81.7
2. ABC.	10	5	248.7	86.3	21.7	8.8	270.4	82.8
3. ABC.	14	7	237.3	82.3	21.6	9.1	258.9	79.2
‡4. Sund.	3	3	189.3	65.7	31.9	16.9	221.2	67.7
5. Sund.	5	5	212.8	73.8	36.0	16.9	248.8	76.2
6. Sund.	7	7	201.3	69.8	34.3	17.0	235.6	72.1
‡7. Double-4	Contin.	Nil	326.3	113.2	63.0	19.3	389.3	119.2
‡8. Control	,,	Nil	288.4	100.0	38.3	13.3	326.7	100.0

‡Sund. = Sunderland System—2 cuts third-daily with long rests.
Double-4 = Two cuts tapped every 4th day; no rest.
Control = Normal alternate-day tapping on single cut.

The results obtained during the first half of the second year of progress of these investigations show that the yields per acre on the A.B.C. system of tapping are gradually rising in relation to the yield on the control system of normal alternate-daily tapping without rest. There is a good indication that the shorter periods of tapping and rest are preferable to the longer periods at least during these early stages of transition from normal alternate-day tapping to an A.B.C. system. The Sunder-

**Annual Report R.R.I. of Malaya* (1933) 78-79.
†*Journal R.R.I. of Malaya* **5**, 320.

land systems are less satisfactory than the A.B.C. systems as regards yield per acre but the saving in tapping costs may be slightly greater. The double-four system has given the most promising return so far, but in common with other double-cut systems, the high proportion of lower-grade rubber obtained is a distinctly bad feature of the two-cut systems of tapping.

C. C. T. S.

(c) *Tapping Experiments on Estates*

Owing to the change in the economic situation occasioned by the introduction of the International Scheme for the Regulation of Rubber Production many of the estate experiments reported upon in 1932 and 1933 were discontinued in 1934. It is proposed to prepare an account of these experiments for separate publication and further detailed results will not be included here. A review of the results of the whole series of experiments was given by Mr. Sharp in a lecture* to the Incorporated Society of Planters which was published in December 1934. Future study of tapping problems will be confined as much as possible to the experimental areas now under our own control but grateful acknowledgment is made to the large number of estate managers who have given such valuable co-operation and assistance in the early investigations over the past three years.

C. C. T. S. and C. E. T. M.

(2) Tapping Experiments on Budded Trees

(a) *Study of Budded Trees under normal Tapping Systems*

The study of budded trees of a number of clones was continued on Pilmoor Estate as in previous years†. Tapping was continued, on virgin bark, on the panel opened in January 1933, at a height of 40 inches from the union of scion and stock. All trees were tapped with a half-circumference, left-to-right spiral cut at a slope of 30 degrees; bark consumption, $\frac{3}{4}$ inch per month on trees tapped alternate-daily and $1\frac{1}{2}$ inches per month on trees tapped daily in alternate months.

The more important records are summarised in Table VIII.

The Planter* (1934) **15, 477.

†*Annual Report R.R.I. of Malaya* (1928) 41; (1929) 51; (1930) 64; (1931) 64; (1932) **72**; (1933) 82.

TABLE VIII. *Summary of Records of Growth, Yield and dry Rubber Content of the Latex of Budded Trees of the principal Pilmoor Clones*

(*a*) *trees tapped alternate-daily*
(*b*) *trees tapped daily in alternate months*

Year	Mean Age of Trees, Years	Mean Girth of Trees in inches at height of 40 inches from Union										
		A. 44		B. 58		B. 84		D. 61		B. 16		D.65
		a	b	a	b	a	b	a	b	a	b	a
1927	3	11.8	11.7	12.2	12.0	13.4	13.6	10.4	11.2	9.2	9.3	13.3
1928	4	15.0	15.1	15.0	14.9	17.1	17.2	12.9	13.8	12.9	12.9	16.5
1929	5	18.7	19.0	19.2	18.8	22.0	22.2	...	...	19.8	19.5	22.8
1930	6	20.8	20.8	20.6	19.8	24.8	24.7	19.3	21.0	21.3	21.5	26.6
1931	7	23.3	23.3	21.8	21.7	27.7	27.5	21.8	23.8	24.5	24.7	30.1
1932	8	24.7	24.4	23.2	22.0	30.5	29.8	23.2	25.4	26.6	26.4	31.9
1933	9	25.7	25.2	25.2	24.1	33.1	32.4	25.4	28.6	28.6	28.2	33.8
1934	10	27.6	26.4	26.7	25.2	36.6	34.4	27.3	30.3	30.4	29.5	36.4

Mean Yield per Tree in pounds dry Rubber per annum

1928	$3\frac{1}{2}$	4.4	...	2.6	...	3.8	...	...	...	...	...	...
1929	$4\frac{1}{2}$	6.0	5.5	4.2	4.8	5.2	6.9	5.1	...	5.5	4.9	4.5
1930	$5\frac{1}{2}$	6.6	6.6	7.2	6.8	7.1	8.1	6.3	6.2	8.7	8.1	11.0
1931	$6\frac{1}{2}$	7.1	8.0	8.7	9.0	9.2	11.3	8.2	8.8	11.4	11.8	15.9
1932	$7\frac{1}{2}$	8.2	8.6	10.2	10.6	12.3	14.3	9.5	10.9	13.0	13.4	19.0
1933	$8\frac{1}{2}$	9.3	8.9	9.6	10.8	15.9	18.5	7.1	10.0	15.1	17.3	20.0
1934	$9\frac{1}{2}$	9.5	10.3	12.9	13.7	18.5	20.0	10.9	13.9	18.6	20.6	26.0

Percentage dry Rubber Content of Latex, mean for each tapping year

1931	$6\frac{1}{2}$	33.6	34.1	37.9	34.1	35.4	33.4	33.4	32.1	36.4	34.6	32.2
1932	$7\frac{1}{2}$	37.7	36.8	43.0	37.3	39.0	35.2	32.7	33.9	37.9	36.1	34.5
1933	$8\frac{1}{2}$	37.1	37.5	43.5	40.3	36.6	34.3	34.8	36.3	37.3	36.6	32.7
1934	$9\frac{1}{2}$	39.3	38.6	42.7	38.1	38.0	35.3	35.5	37.3	39.9	37.8	32.8

There has been an increase in the yields of all clones; in Clones A. 44, B. 58 and D. 61 the increase is small but for Clones B. 84, B. 16 and D. 65 the increase is quite considerable; Clone D. 65 is outstanding. Towards the

end of the year, on many of the trees the tapping cut approached the renewed bark of the first panel opened at a height of 20 inches in 1928 but no decrease in yield was observed. The renewed bark is excellent on clones B. 84, B. 16 and D. 65, and even on the inferior clones the condition of the renewed bark is quite satisfactory. It is interesting to note that in all clones the daily alternate-monthly system of tapping has given slightly higher yields than the alternate-daily system. Full details of the incidence of disease and losses from mechanical damage were given in the last report; during the current year two further trees of Clone A.44 have been destroyed by storm damage and there have been three new cases of brown bast, one in each of the clones, B. 58. B. 84 and B. 16.

C. E. T. M. and K. N. K.

(b) *Influence of Tapping Height on Yield of Budded Trees*

With the completion of the second tapping panel the study of differences in yield of buddings of the principal Pilmoor clones when tapped at different heights from the union were discontinued. The experiments on Clones B.50 and B.95 were continued and the summary of yield records for the first two years of tapping are given in Table IX.

TABLE IX. *Yields of budded Trees tapped at different tapping Levels*
Heights given are those measured on January 1st, 1934

Clone	Tapping year	Yields in grm. per Tree per Tapping at Heights of:—				
		10 inches	20 inches	30 inches	40 inches	50 inches
B. 50	1933	18.2	16.2	14.8	14.0	12.6
	1934	21.3	16.4	16.5	15.5	12.1
B. 95	1933	—	17.1	—	14.0	
	1934	18.2	—	17.7	—	

The relatively small decrease in yield with increase in the height of the tapping cut is again demonstrated.

C. E. T. M. and K. N. K.

(c) *Influence of the Direction of the Tapping Cut*

In continuation of the experiment reported in 1933 the records of yield of buddings of Clone B. 95 tapped from left to right are compared with those of trees tapped from right to left. The superiority of the left-to-right slope has been maintained (Table X).

TABLE X. *Influence of the Direction of the Tapping Cut on Yield of Budded Trees*

Clone	Tapping Year	Yield in grm. per Tree per Tapping		
		Tapped left to right	Tapped right to left	Right-to-left as per cent left-to-right
B. 95	1933	14.0	10.3	74.6
	1934	17.7	14.6	82.5

(d) *"Double-cut" Tapping Systems on Budded Trees*

The experiments described in the report for 1933 were continued and the results for the first two years of the tests are given in Table XI.

The tables show the actual yield per tree in grams dry rubber per tapping and the total yield in pounds per tree per annum.

Despite the apparent severity of the tapping operation there has been no sign of damage to the trees, no incidence of brown bast and bark renewal appears normal. It is proposed to repeat these tests on buddings of a large number of the well-known proved clones on the Experiment Station in 1935.

C. E. T. M. and K. N. K.

(e) *Influence of different Tapping Systems on the Yield of Buddings*

The experiments with different tapping systems on clone Glenshiel 1 were discontinued at the end of 1933 and during 1934 comparisons have only been made between alternate-daily tapping on half-circumference and on one-third-circumference, and third-daily tapping on a half-circumference. (Table XII).

TABLE XI. *Comparison of Yields of Budded Trees on single and double-Cut Tapping Systems*

System of Tapping	Tapping Year	Average Yield per Tree per Tapping in grams and pounds per annum (160 tappings for single cuts and 80 tappings for 2 cuts)							
		Clone B. 95		Clone C. 94		Clone B. 65		Clone D. 29	
		grams	pounds	grams	pounds	grams	pounds	grams	pounds
Single tapping cut on half-circumference	1933	13.7	4.8	20.7	7.3	20.6	7.2	16.6	5.8
	1934	16.8	5.9	26.2	9.2	25.3	8.9	22.6	7.9
Two cuts on opposite panels both on half-circumference	1933	30.7	5.4	34.2	6.1	38.1	6.8	30.3	5.4
	1934	40.1	7.1	49.9	8.8	50.0	8.8	38.7	6.9
Yield of double-cut trees as per cent yield of single-cut trees	1933	113		84		94		93	
	1934	120		96		99		87	

Note. Clone B. 95. Double-cut trees tapped alternate-daily for periods of 3 months and rested for periods of 3 months.

Single-cut trees tapped alternate-daily.

Clones C. 94, B. 65 and D. 29.
Double-cut trees tapped daily for 15 days and rested for 45 days.

Single-cut trees tapped daily in alternate months.

Since October 1933 the oldest trees, first vegetative generation, have been tapped on renewed bark six to seven years of age. It will be noted that yields have been satisfactorily maintained. Previous study had indicated that alternate-daily tapping on half-circumference without rest may prove too severe a system for this clone. This view is supported by the records of the yield of the trees of the second vegetative generation. During 1934 trees tapped alternate-daily on one-third-circumference cuts or on half-circumference cuts third-daily, have maintained a higher level of yield than trees tapped alternate-daily on half-circumference cuts without rest.

TABLE XII. *Yield of Buddings of Clone Glenshiel 1 on different Tapping Systems*

System of Tapping	Age of Trees on 1.1.34	Yield in grams per Tree per Tapping and pounds per Tree per annum			
		1933		1934	
		gm.	lb.	gm.	lb.
Alternate-daily on ½ circumference	12 years	73.5	25.9	62.7	22.1
Alternate-daily on ⅓ circumference	12 years	55.7	19.6	48.3	17.0
Alternate-daily on ½ circumference	6½ years	28.6	10.1	21.0	7.4
Alternate-daily on ⅓ circumference	6½ years	28.5	10.3	26.2	9.2
Third-daily on ½ circumference	6 years	—	—	25.0	8.8

We are again indebted to Mr. J. H. H. Bailie and Mr. W. A. D. Wynch for their continued interest in these experiments and for permission to make use of their records.

C. E. T. M.

(3) ANATOMICAL INVESTIGATIONS

The anatomical investigation of the sieve-tube system in Hevea has been carried on throughout the major portion of the year. It has been established that the diameter or tube-bore of the sieve-tubes varies considerably in different trees, the smaller sieve-tubes often measuring not more than one-fourth of those of the more highly developed type. It has also been established that the number of tubes per unit area of the cross-section of the bast likewise varies from tree to tree. In the present investigation an attempt has been made to ascertain whether the capacity to yield latex is related in some manner with the degree of development of the sieve-tubes. Is it possible that large tubes are uniformly

associated with high yield capacity and small tubes with inferior yield capacity? The sieve-tubes make their appearance with the initiation of secondary thickening in the first year of growth. If then it could be definitely shown that yield is closely correlated with sieve-tube diameter and distribution, the high or low yielding potentialities of a plant could be foreshadowed by analysis of its sieve-tube complement in the first year of life as a seedling. Under the present system of test-tapping a tree must be allowed to grow for a period of at least three years before the tapping test can be applied and it is unnecessary therefore to stress the urgency of exploring other lines of approach whereby the waiting period can be curtailed.

The present investigation has been carried out on some 70 established clones of authentic high-yielding capacity and on 200 six-years-old seedlings established at the Experiment Station, for which tapping records are available for two years. In addition, 200 two-years-old untested clones derived from high-yielding Malayan mother-trees have been examined and recorded for future yield comparison.

In all the clonal material, bark samples from at least three trees per clone have been utilised in order to eliminate the possibility of inclusion of "rogues" in the material prepared for microscopic study. For convenience of analysis the six-years-old seedlings have been divided into three groups according to yield records:

Low	Yield	4 lb. and under	(160 tappings)
Medium	„	5— 9 lb.	„
High	„	10—20 lb.	„

The results present features of considerable interest:

(a) The 70 established clones without exception, and the highest-yielding group of the six-years-old seedlings with two exceptions, were endowed with sieve-tubes of large diameter (0.04 mm.). Variation in the intensity of distribution per unit area of cross-section occurred but was not correlated with yield differences within the group.

(b) Members of the low-yielding group of seedlings with one exception were equipped with sieve-tubes of uniformly small diameter almost indistinguishable from the surrounding tissue.

(c) The medium yielders however presented a somewhat conflicting picture. Thus in the lower section of the group (4—6 lb.) both small and large diameter tubes

were present in different individuals with a dominance of 3 to 2 in respect of the small type. In the upper section of the group the large tubes gained the ascendant in the proportion of 4 : 1.

Of the 200 trial clones derived from Malayan mother-trees 90 per cent were endowed with sieve-tubes comparable to those of high-yielding clones. Further consideration of the data on these improved clones must be deferred until tapping records are available.

The results obtained from the clonal material and from the definitely low and high-yielding categories of the seedlings provide very strong evidence in support of the suggestion made above that qualities of low and high yield may be correlated with the degree of development of the sieve-tube system. The presence, however, of both small and large type sieve-tubes in the group of trees adjacent to the low-yielding category necessitates a qualified acceptance of this view until the cause of this apparently aberrant condition is elucidated. The presence of relatively low-yielding individuals in a group possessing sieve-tubes of large diameter does not necessarily invalidate the hypothesis of correlation, for the tapping records of high-yielding clones reveal on occasion wide departures from the normal expectation, induced by soil deficiencies, local climate and possibly incidence of disease. Moreover, a similar variation in clonal material has been shown to occur in annual yield increment which may be a record of steady or of phenomenal increase, necessitating several years of tapping and recording before a correct evaluation is obtained. These considerations must be taken into account in respect of trees possessing sieve-tubes of large diameter and from which on the basis of yield correlation, high yields are to be expected.

The position with regard to trees endowed with small diameter sieve-tubes is somewhat different. For trees of this type it is postulated that the individuals are of permanently low yielding capacity and their inability to yield large quantities of latex may be due to a restricted food supply imposed by the relatively inefficient character of the sieve-tube system.

H. G.

III. Selection and Breeding

(1) Selection of high-yielding Trees on Estates and the Establishment of New Clones

The work on this subject has been confined to maintenance of and observations on the clones established; no additions have been made to the collection since 1933.

C. C. T. S.

(2) Artificial Pollination and Breeding

No further work has been done on these problems as regards the development of new material but the test-tapping of some of the oldest seedlings planted in late 1928 and during 1929 was repeated in January and July 1934. In December all trees in the experimental area (Block 4, R.R.I. Experiment Station) having a girth of 20 inches or more at a height of 20 inches from the ground were marked with a half-circumference left-to-right cut at a slope of 22 degrees in preparation for regular alternate-day tapping from January 1st, 1935.

The results of the test-tappings carried out in July 1933 and in January and July 1934 are summarised in Tables XIII and XIV.

Table XIII. *Results of test Tapping of 1928 Crosses—Legitimate Seedlings*

Age in July 1933 4 years 2 months
„ „ Jan. 1934 4 „ 8 „
„ „ July 1934 5 „ 2 „

Cross M	Cross F	No. of Trees tapped	Mean Yield per Tree per Tapping in grm. dry Rubber			Lowest Yield in grm. obtained during periods			Highest Yield in grm. obtained during periods			Coefficient of variability		
			July 1933	Jan. 1934	July 1934	July 1933	Jan. 1934	July 1934	July 1933	Jan. 1934	July 1934	July 1933	Jan. 1934	July 1934
A. 8	A.44	3	4.2	25.4	27.3	3.4	10.3	18.3	5.3	37.6	33.4			
B.58	A. 8	6	3.8	16.7	23.9	0.9	3.7	5.3	8.4	26.4	37.1			
A.44	B.58	4	7.2	26.6	41.5	5.5	15.6	22.7	9.1	38.5	58.4			
A.44	D.61	17	4.6	18.1	30.4	1.5	7.1	11.8	9.2	28.9	48.0	44.3	35.6	38.0
A.44	B.16	10	4.5	16.8	26.8	3.1	7.1	5.2	6.7	28.2	39.3	25.3	36.4	36.6
B.58	A.44	2	5.6	23.0	33.5	2.4	12.4	21.1	8.8	33.5	45.9			
B.84	A.44	3	7.5	20.4	63.4	3.6	4.9	23.0	10.2	48.4	96.5			
D.61	A.44	19	5.8	20.1	35.3	1.7	4.3	11.5	13.8	40.2	62.7	53.2	51.7	40.6
B.95	A.44	5	6.6	19.1	28.9	2.4	7.8	14.4	16.6	31.7	39.5			
B.58	B.16	2	3.6	4.8	23.8	2.4	2.9	22.7	4.7	6.7	24.9			

The results summarised in Table XIII above show that the seedling families obtained by careful hand-pollinations between high-yielding clones are likely to be very much superior in yield to ordinary seedlings of unknown parentage, and may even rival buddings of first-class clones in their production capacity. The figures presented here can only be used as an indication of the future value of the seedlings for only a small proportion of the trees was tapped. At the same time it will be noticed that certain families are of great promise; all families in which A.44 has been used as a parent are excellent. The cross A.44 × B.84 may prove to be exceptionally valuable. A tree which is capable of yielding 96.5 grams of dry rubber, i. e. 3.4 ounces, per tapping, even though this was for a short period of only 15 tappings, is of outstanding merit. Buddings have already been made from such valuable new mother-trees and tapping will commence on these buddings in July 1935.

TABLE XIV. *Results of test Tapping of illegitimate Seedlings from Buddings of the parent Clones ("Clonal Seedlings")*

Age in July 1933 = 4 years 2 months
„ „ Jan. 1934 = 4 „ 8 „
„ „ July 1934 = 5 „ 2 „

Illegitimate seedling Trees		No. of Trees tapped	Mean Yield per Tree per Tapping in grm. dry rubber			Lowest Yield in grm. obtained during periods			Highest yield in grm. obtained during periods			Coefficient of variability		
			July 1933	Jan. 1934	July 1934	July 1933	Jan. 1934	July 1934	July 1933	Jan. 1934	July 1934	July 1933	Jan. 1934	July 1934
Clone	A. 8	11	3.9	15.5	23.2	1.4	5.6	8.1	9.9	31.1	49.5	68.2	54.5	59.3
„	A.44	70	4.8	14.8	21.6	0.8	3.2	4.0	22.7	51.6	83.0	81.7	64.4	68.5
„	B.58	34	2.6	10.7	15.0	0.4	0.9	1.4	7.0	27.6	39.0	65.2	61.5	58.8
„	B.84	5	2.6	23.0	16.0	1.7	8.5	11.3	3.8	62.7	21.8			
„	D.61	5	3.1	11.0	18.8	1.6	6.8	9.8	6.0	17.3	29.7			
„	B.95	6	1.7	6.4	9.0	0.5	2.1	2.5	2.6	10.8	15.1			

The data presented in Table XIV are from a parallel series of tests (each test consisted of one month of normal alternate-daily tapping—15 tappings) on illegitimate

seedlings from some of the parents used for hand-pollination work. The seed from which these trees were grown was collected in the ripe pods direct from the parent budded trees, or from the ground beneath them. All seed was identified by seed-coat characters, so that the female parent is known in each group but the male parent is unknown. Seed of this type collected from budded trees is commonly known as 'clonal' seed. These illegitimate seedlings from the high-yielding parent clones, although not so good on the whole as the legitimate crosses, are still very much superior to ordinary unselected seedlings. It is particularly interesting to note that the illegitimate seedlings derived from clone A.44 give almost as high yields as the average of the crosses in which A.44 is a parent. Another point of interest is that the buddings of clone A.44 are not outstanding; in order of merit based on yield A.44 stands sixth in the list of parent clones from which these seedlings have been derived.

The experimental plot in which this work was carried out was the first plot planted by Mr. L. E. Morris who held the post of Geneticist at the Rubber Research Institute prior to the operation of retrenchment proposals in 1932. The subsequent maintenance of the work and study of the material established by Mr. Morris has been carried out by Mr. Kaimal and the writer.

C.E.T.M. and K.N.K.

(3) Study of Seedlings derived from high-yielding Clones

(a) *Variation within Seedling Families*

Seedlings grown from the seed of single selected mother-trees, both buddings and seedlings, planted in December 1928 have been tapped in the same manner as the crosses and illegitimate seedlings described under (2) above. The results are summarised in Table XV.

The object of this work is to study the variation in yield which occurs within a single seedling family. This information is required in connection with thinning of seedling areas and to give an indication of the extent to which the average yield of a seedling family may be improved by elimination of the least productive trees. The greater the degree of variation found the greater will be the degree of improvement which can be effected by selection. The degree of variation can be expressed in convenient mathematical form and the expression

TABLE XV. *Variability in Yield of the illegitimate Seedling Offspring of a single Mother-Tree or Clone*

Age in July 1933 = 4½ years
„ „ Jan. 1934 = 5 „
„ „ July 1934 = 5½ „

Illegitimate seedling Trees of mother-Trees	No. of Trees tapped	Mean Yield per Tree per Tapping in grm. dry Rubber			Lowest Yield in grm. obtained during periods			Highest Yield in grm. obtained during periods			Coefficient of Variability		
		July 1933	Jan. 1934	July 1934	July 1933	Jan. 1934	July 1934	July 1933	Jan. 1934	July 1934	July 1933	Jan. 1934	July 1934
Pilmoor													
A.44— 79	19	5.9	18.5	26.0	1.3	5.1	11.0	20.2	49.7	72.8	79.0	62.2	64.1
„ — 81	35	5.9	18.8	26.7	1.3	6.7	10.1	17.5	44.3	53.7	62.0	46.9	46.1
„ —168	17	6.5	20.6	31.6	1.3	9.4	12.9	15.5	35.9	51.3	64.7	41.2	38.9
D.61—700	45	2.6	10.5	16.6	0.6	2.2	3.1	6.0	25.1	38.9	52.4	55.0	54.0
Kuala Kangsar L.	32	2.0	6.7	9.4	0.3	1.8	1.6	4.9	17.4	22.5	58.8	52.4	51.4

"coefficient of variability" is used. In a mixed population of seedlings of unknown parentage the value of the coefficient of variability may exceed 90; for buddings of a single clone the value is about 25. It will be seen that from the seedling families studied here the value of the coefficient is intermediate between these limits. Why budding No. 79 of clone A.44 should have given such a variable family is not yet understood but it will be seen that the degree of variation in all the remaining families is comparatively uniform and low. Reference should also be made to Tables XIII and XIV in which it is shown that the variation within a family of legitimate seedlings may be very much lower than the variation within groups of illegitimate seedlings from the same parents. The actual yields of the seedlings of clone A.44 in the present experiment are again very satisfactory.

C. E. T. M. and K. N. K.

(b) *Seedlings from Isolated Seed Gardens*

Seedlings obtained from the isolated seed gardens on Batu Kawan Estate, Province Wellesley have been planted in additional plots on the Experiment Station during the

year. A total area of 8 acres has now been planted with this material.

(c) *Seedlings from Buddings of proved Clones in commercial Plantations*

(i) An area of approximately 11 acres (Block 26, R.R.I. Experiment Station) has been planted with illegitimate seedlings grown from seed collected from eight of the clones planted in Block 5. The clones are, A.V.R.O.S. 49, 50, 152, P.B. 23, 186; Tjirandji 1, Pilmoor B. 84 and A. 44.
(ii) A further large area of 50 acres (Block 27, R.R.I. Experiment Station) has also been planted with 'clonal' seedlings of A.V.R.O.S. 49 and 50 from large monoclone plantings, mixed clonal seed derived from several proved clones on different estates, unselected seedlings and seedlings for budding in the field for comparative study.

C. E. T. M., C. C. T. S. and K. N. K.

(4) Methods of Test Tapping and their Value in Selection and Thinning in Seedling Plantations

The objects of this work and results obtained up to the end of 1933 were fully described in the *Annual Report* 1933. The tapping tests were repeated in January and July 1934 and the results are tabulated below. The trees used were brought into regular tapping from January 1st, 1935, and individual tree records are being kept for all trees in the area (Block 2, R.R.I. Experiment Station).

To simplify as much as possible the work of recording the correlation between total yields over a short test period and yield over the whole period was obtained. The results are shown in Table XVI. The very high degree of correlation obtained in all cases justifies the use of the record for the short period as a reliable index for further calculations.

The correlations between the yield obtained during the first test when the trees were three years of age, and the yields recorded in successive test periods have been worked out for each test. In a general way the value of the coefficient decreases gradually for each successive test but it is always sufficiently high to be fully significant. The interpretation is that the early test at three years is for all practical purposes sufficiently reliable as a basis of classification of the trees. The relevant data is presented in Table XVII.

TABLE XVI. *Correlation between total Yield for the second Group of five Tapping Days and the Yield over the whole Test Period*

System of Tapping	1st period	2nd period	3rd period	4th period	5th period	6th period
Tapped A.D. for 30 days	+ 0.97	+ 0.99	+ 0.97	+ 0.99	+ 0.97	+ 0.99
Tapped Daily for 30 days	+ 0.92	+ 0.94	+ 0.95	+ 0.96	+ 0.95	+ 0.95
Tapped Daily for 15 days	+ 0.99	+ 0.98	+ 0.96	+ 0.99	+ 0.97	+ 0.98

TABLE XVII. *Correlation between Yields of Seedling Trees in successive Tapping Periods*

System of Tapping (All cuts on ½ circ.)	Coefficient of Correlation between individual Yields obtained during the second five days of the first period and the same of the:—				
	2nd period	3rd period	4th period	5th period	6th period
Tapped A.D. for 30 days	+ 0.93	+ 0.82	+ 0.77	+ 0.79	+ 0.64
Tapped Daily for 30 days	+ 0.90	+ 0.88	+ 0.98	+ 0.85	+ 0.83
Tapped Daily for 15 days	+ 0.91	+ 0.74	+ 0.88	+ 0.74	+ 0.78

The results indicate that daily tapping is probably more reliable than alternate-daily tapping for early tapping tests. It is intended to continue this work now that the trees are in regular tapping, comparing their yields in practice with the early test-tapping records.

C. E. T. M. and K. N. K.

IV. Indigenous Cover Plants in Rubber Cultivation: Ecological Studies

(1) Ecological surveys in the Lake Gardens area have been continued in collaboration with the Soils Division. The changes in composition of the natural flora in various plots is being studied in relation to methods of treatments of slashing and pruning.

K. N. K.

(2) During the year two large-scale field experiments have been initiated on the R.R.I. Experiment Station.

(a) Block 26 (11 acres) consisted of secondary jungle of six years regeneration from the date of the original felling in 1928. Avenues about 8 feet wide were cut through the secondary growth following contours, terraces were prepared and planting was completed with seedlings in baskets. Secondary growth between the planting terraces was then lopped to a height of about 4 feet and *debris* piled between the terraces. Subsequent control has been by general slashing of all species to a height of 3 to 4 feet at intervals of from four to six months. Except for the eradication of *lalang* it is not intended to practice any selection of species in this natural cover. Changes in its composition with development of shade from the rubber trees will be carefully followed.

C. E. T. M. and K. N. K.

(b) Block 27 (50 acres) has been opened from jungle during the year by special methods, which are described in detail in the Report of the Manager of the Experiment Station. The area is divided into a replicated plot experiment in which three methods of cultivation and control with indigenous cover plants will be compared with cultivation with shrubby leguminous cover plants and creeping leguminous covers. The supervision of this experiment is in the hands of the Manager of the Experiment Station and detailed ecological work is being carried out by the Botanical Division.

H. W. F. and K. N. K.

V. Field Experiments on the R.R.I. Experiment Station, Sungei Buloh

The following additions are made to the schedule of field experiments published in the *Annual Reports* for 1932 and 1933*.

Block Number	Acreage	Description of Experiments in Progress	Date of commencement
1A	3	Testing value of clonal seedlings from Batu Kawan Estate Isolated Seed Garden. Families A.V.R.O.S. 157 and 49, P.B. 25.	May 1934
16F	2½	As above but with seedlings of Clone B.D. 5 only.	May 1934
26	11	Testing value of seedling families derived from clones A.V.R.O.S. 49, 50, 152, Prang Besar 23 and 186, Pilmoor B. 84, A. 44, and D. 65, Tjirandji 1.	April 1934
27	50	Randomised block experiment allowing for repetitions of each type of planting material and each cultivation treatment to compare:—	
		(a) Seedling plantings with various types of clonal seed with buddings of good clones.	Oct. 1934
		(b) Different methods of cultivation with indigenous and leguminous cover plants.	April 1934

VI. Advisory Work

CORRESPONDENCE

The detailed analysis of advisory correspondence dealt with by the Botanical Division appears in the appendix

**Annual Report R.R.I. of Malaya* (1932) 87-90.
Annual Report R.R.I. of Malaya (1933) 101-102.

to the Report of the Director. The volume of correspondence remains about the same as in 1933, and the nature of the enquiries dealt with has been very similar. Towards the end of the year, however, the amount of advisory work increased rapidly chiefly in connection with enquiries arising out of the application of the rules for rubber regulation. Considerable time was spent on the preparation and collation of data on budded rubber for the information of the Rubber Assessment Committee. The examination of data relating to clones which had been developed by private enterprise but concerning which no records had been published and no material had been offered for sale for general commercial planting, also occupied a good deal of time and in several instances it was necessary to carry out additional field experiments in order to obtain or confirm the information required.

A comparatively new development of our advisory work arose in connection with enquiries on the subject of replanting. Close collaboration with the Soils Division is necessary in this work and additional study of the characteristics of the well-known proved clones has been required.

In much of our advisory work it is necessary to lay down field experiments. The estate staffs are responsible for the field work involved but the analysis or records, weighing of rubber samples and collection of field data, is largely carried out by the staff of the Botanical Division.

Experiments on the establishment of new clones, tapping of budded trees, tapping of seedling trees and replanting have been planned and are controlled by the Division on thirteen estates in various parts of the country.

Estate Visits

The total number of visits paid by members of the senior staff to estates on advisory and research work was 294.

Member of Staff	*Advisory visits*	*Research visits*
C.E.T.Mann	90	60
C.C.T.Sharp	11	90
H.Gunnery	2	9
K.N.Kaimal	-	32
	103	191

Interviews and Visitors

During the year 78 visitors, estate managers or agents visited the laboratory to discuss various aspects of botanical work applied to estates. This number does not include the large number of visitors who were met on the Experiment Station.

Lectures

Mr. C. C. T. Sharp; Annual Conference of the Incorporated Society of Planters, Kuala Lumpur, 15th Sep-

VII. Publications

(1) "Tapping Experiments on Budded Trees" by C. E. T. Mann

R.R.I. Journal Vol. 5, No. 2, p. 90

(2) "Tapping Experiments on Budded Trees. Experiments on Pilmoor Estate, I" by C. E. T. Mann, F. Billington and K. N. Kaimal

R.R.I. Journal Vol. 5, No. 2, p. 97

(3) "Tapping Experiments on Budded Trees. Experiments on Pilmoor Estate, II", by E. Rhodes and C. E. T. Mann

R.R.I. Journal Vol. 5, No. 2, p. 113

(4) "Notes on the Yield Performance of Budded Trees of Proved Clones in Commercial Practice", by C. E. T. Mann

R.R.I. Journal Vol. 5, No. 2, p. 139

(5) "A Note on the Transplanting of Budded Stumps of Hevea" by L. E. Morris

R.R.I. Journal Vol. 5, No. 2, p. 145

(6) "Observations on the Completion of the Union in Buddings of *Hevea brasiliensis* made on Large Stocks" by C. C. T. Sharp

R.R.I. Journal Vol. 5, No. 2, p. 152

(7) "Experiments with Economic Tapping Systems (I)" by C. C. T. Sharp
R.R.I. Journal Vol. 5, No. 4, p. 320

(8) "Notes on a Tapper's Working Time" by C. C. T. Sharp
R.R.I. Journal Vol. 5, No. 4, p. 335

(9) Supplementary Sheet No. 1 to "The History and Description of Clones of *Hevea brasiliensis*" by C. E. T. Mann and C. C. T. Sharp
Planting Manual No. 5

(10) "Tapping Systems" by C. C. T. Sharp
The Planter Vol. 15, No. 12, p. 477

C. E. T. Mann
Senior Officer, Botanical Division.

Kuala Lumpur,
11th July, 1935.

ANNUAL REPORT

PATHOLOGICAL DIVISION

Staff

At the end of 1933 the staff consisted of Mr. A. Sharples, Head of the Division, and Messrs. F. Beeley and R. P. N. Napper as Pathologists. Unfortunately the Division lost the services of its Head on the voluntary retirement of Mr. Sharples on the 5th of February, 1934. For the remainder of the year Mr. Beeley took charge of the work affecting diseases above ground and Mr. Napper attended to the diseases attacking rubber below ground. This arrangement continued to the end of the year when Mr. Napper departed on home leave on December 28th, 1934.

The Division was again fortunate in having the honorary services of Mr. Choo Kok Leong, B.A. (Oxon), for the whole of the year. The assistance he has given is greatly appreciated. We are again pleased to record the loyal and valuable assistance given to us throughout the year by the Asiatic junior staff.

Research

Despite the demands made upon the time of the two remaining European Officers by the routine correspondence and advisory work the research work has made considerable progress. Our knowledge of the influence of environmental factors upon the incidence and virulence of diseases like Mouldy Rot, Oidium Leaf Mildew and Phytophthora diseases has made considerable advances. These will be mentioned under the various disease titles.

In the latter part of the year work on the bacteriology and preservation of latex was commenced in co-operation with the Chemical Division, as a result of which we now have a better understanding of the micro-organic activity in fresh and preserved latex and its bearing on the keeping-qualities of field latex.

Root Diseases

Fomes lignosus (White Root disease), *Ganoderma pseudoferreum* (Red Root disease) and *Fomes noxius* (Brown Root disease) are the three common root disease fungi occurring on rubber.

Throughout the year the usual steady stream of enquiries on root disease control has been received. Particular attention is now being paid to the control of root diseases under conditions where natural covers and rubber seedlings have been allowed to develop and to disease control in areas recently replanted, or about to be replanted, which previously carried a stand of old rubber considerably reduced by the activity of root disease fungi.

Root disease investigations therefore have taken the form chiefly of field experiments under the supervision of the Institute on estates in co-operation with the managers. These investigations confirm the views expressed in the *Annual Report 1933*, pp. 105-111, viz., that the chief means of propagation of the three main root diseases is by means of rhizomorphs which can spread only over hard surfaces, preferably roots and which, so long as food from the parent fungus body is obtainable, are capable of growing along the surface of living rubber roots. The rhizomorphs on the surface of these roots continually produce mycelium which enters the bark and subsequently penetrates to the centre of the wood. Thus, under favourable circumstances, infection and parasitisation continues to spread along the roots towards the bole of the tree. Further, it has been shown that the source of infection of rubber trees arises from infected timber from the original jungle stand, chiefly by contact of living rubber roots with buried infected jungle logs.

The buffering effect of controlled "forest conditions" on the spread of root disease can be explained by the loss of vigour of the rhizomorphs owing to their division into many small unit branches in an endeavour to find a way through the maze of roots existing in forest-covered soils. Conversely, the absence of small roots and the presence of a few large roots to form a simple path for the rhizomorph, would tend to increase the rate of spread of root diseases.

In the matter of replanting areas of old rubber in which the stand of trees per acre has been greatly reduced by the effects of root disease, it is deemed advisable to effect complete eradication of all infected roots within the disease patches by systematically digging over and taking particular care to extract the diseased tap roots. If the disease patches are demarcated by isolation trenches it will be necessary to dig over the soil within the diseased area only. Outside these isolated areas it is necessary to examine a row of trees on the periphery in case infection may have occurred outside the trenched zone, while the remainder of the trees, being healthy, may be sawn off near

ground level and the root system left in the soil to rot and form humus.

During the year the increasing importance of the root disease caused by *Fomes noxius* has been noted. The disease appears to be of wide occurrence and has been found on many types of soil. The similarity of its rhizomorphic spread to that of the other two root disease fungi has been demonstrated.

Ustulina Zonata

When a rubber tree has reached "maturity" and been in tapping for a few years, say from the tenth year onwards, it frequently happens that trees attacked by *Ustulina zonata* at ground level are treated as cases of root disease. As this disease spreads into the bole of the tree the food supplies to one or more of the lateral roots may be cut off causing the death of the root, thus enhancing the case for the diagnosis of root disease.

The occurrence of *Ustulina* at the collar is in the great majority of cases due to bad tree sanitation owing to bark and earth scrap being allowed to accumulate at the base of the trees. This scrap ferments on the bark surface, causing death of the bark and providing the necessary footing and entrance for *Ustulina*. Periodical removal of earth scrap and cleansing the base of the panel of all trees in tapping is essential if losses from this disease are to be minimised.

Diseases of the Tapping Panel

Mouldy Rot *(Ceratostomella fimbriatum)*

This disease continues to receive a considerable amount of attention. The danger of allowing a too heavy stand of natural undergrowth has been realised and in many cases a return to frequent slashing and maintenance of low natural covers only has been adopted. In other cases wide ring-weeding round the trees combined with contour terraces has enabled the necessary supervision and treatment to be maintained.

During many tests conducted throughout the year the superiority of the tar distillate emulsions has again been demonstrated. Under estate conditions in the first treatment the tapping panel and the untapped surface beneath should be sprayed with fungicide of appropriate strength as mentioned in the *Annual Report 1933*, p. 113. Subsequently the renewing bark and tapping-cut region should be sprayed each tapping day with

the same fungicide. This regular spraying should continue until the disease disappears or until dry weather intervenes, when the fungus usually becomes inactive. If, however, damp weather continues after full control of the disease has been obtained spraying every fourth tapping day with the same fungicide should be carried out to prevent a return of the disease. In this way complete control of areas with 100 per cent infection has frequently been obtained within fourteen days despite continued daily tapping.

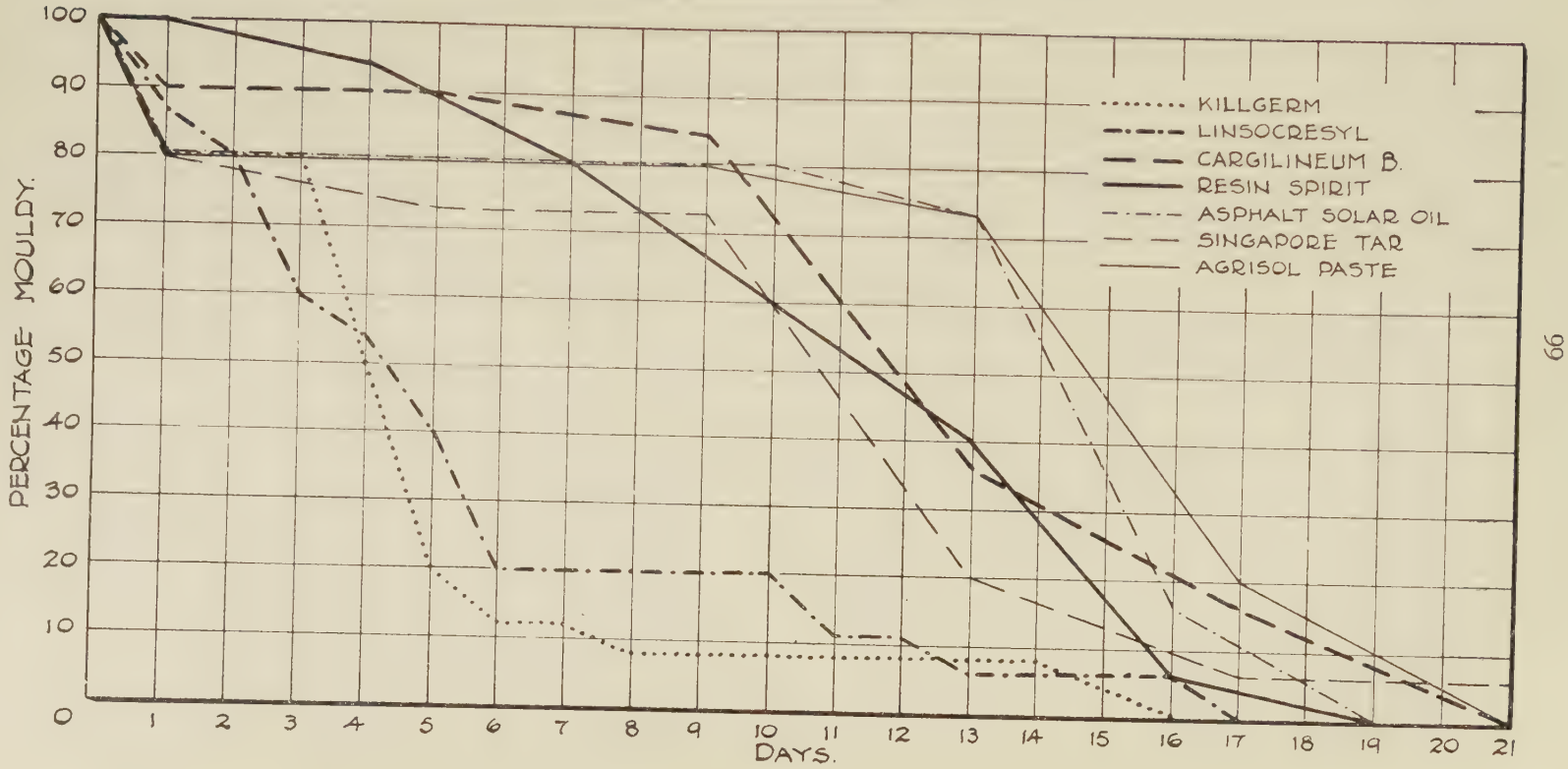
The Institute's circular on the control of this disease was revised to incorporate the latest views and a complete list of the fungicides officially tested and approved for use in control of this disease.

During the year eight proprietary preparations have been tested with a view to placing them on the "White List" of approved fungicides. All of these failed to pass the necessary tests and the official list remains as published in the *Annual Report 1933*, p. 113.

The chief defect observed in the fungicides tested this year was the fact that killing of the bark took place at or below the concentration necessary to kill the fungus. The need for a margin of safety is not realised by many proprietors of fungicides.

As a point of interest one might here record an experiment to demonstrate the efficiency of the various types of fungicides used for the control of the disease in the heavily-infected smallholdings rubber areas. The materials used were Killgerm (a proprietary fungicide) and Linsocresyl (prepared in the Pathological Division), as representatives of the tar-acid emulsions, Cargilineum 'B' mixture and Agrisol Paste (both proprietary fungicides), as representatives of the greasy water-proof pastes: Singapore Tar and Asphalt-Solar Oil plus 10 per cent Brunolinum, as representatives of the black waterproof paints which find a fairly wide use. A resin-spirit mixture in common use in the Netherlands Indies was also included, but during the wet weather was found seriously to damage the bark, although on the advent of dry weather early in December further applications proved to have no ill-effects on the renewed bark. The results are given in tabular and graphical form below. The initial degree of infection in each plot was 100 per cent. The condition of the renewed bark was noted weekly and the flow of latex was judged by pricking the renewing bark with a knife point. It has frequently been noticed that, if the fungicide has damaged the bark, even only slightly, the latex flow is poor and the latex produced is of a thin watery nature. The results indicate the superiority of the tar-acid emulsions.

FUNGICIDE TESTS - SETAPAK.
NOV. - DEC. 1934.



Fungicide Tests in Control of Mouldy Rot

Disinfectant	Application	Disease under Control	Condition of renewing Bark	Latex flow
Killgerm 10 per cent. in water	Daily	After 16 applications	Very good	Good
Linsocresyl 10 per cent. in water	Daily	After 17 applications	Good	Good
Cargilineum undiluted	Every 4th day	After 6 applications	Fair to good	Good
Resin Spirit	Every 3rd day	After 6 applications	Hard crust formed. Bark damaged in wet weather. Renewal of bark good in dry weather	Fair to good
Singapore Tar	Every 4th day	After 7 applications	Burning where the bark is tapped deeply otherwise good bark renewal	Fair
Asphalt-Solar Oil plus 10 per cent. Brunolinum	Every 3rd day	After 7 applications	do.	Fair to good
Agrisol Paste	Every 4th day	After 6 applications	do.	Fair

Brown Bast

This disease has received considerable attention during the year. New, thickly-planted areas recently opened for tapping preparatory to thinning appear to develop a stage of Brown Bast previously thought to be a transitory stage to the true brown speckled stage. The tapping cuts run dry and the bark appears greyish in colour. Microscopic investigation soon demonstrates the death and gumming of the latex vessel system.

To avoid serious losses through this disease a careful check must be kept on the dry rubber content of the latex from each field, clone or even task. If the dry rubber content falls to a low figure it is an indication that cell fluids, other than caoutchouc-bearing fluids, are being withdrawn from the latex vessels. This situation quickly leads to the drying and death of the latex vessels and the development of Brown Bast. It is obvious that the only way of preventing the incidence of this disease is to adopt a less severe system of tapping so as to avoid the withdrawal of excessive amounts of the vital cell fluids.

A circular describing the disease, its causes, prevention and control has been prepared and is available for distribution.

Black Stripe and Patch Canker (*Phytophthora* sp.)

The situation in regard to these diseases is very similar to that of last year. The coastal districts remain the chief areas affected. Treatment with a water-miscible fungicide easily prevents damage to the tapping panel.

Sun-scorch

Sun-scorch of the tapping panel continues to occur, especially during the wintering season when shade, owing to the reduced leaf canopy, is practically non-existent. The present recommendations for treatment are to apply a weak solution of a water-miscible fungicide followed by a coating of limewash to serve as a heat reflector and thus maintain the bark in a reasonably cool condition.

In this connection the following experiment is of interest.

Five glass tubes of 1¼ inch diameter were filled with water and plugged with a cork through which passed a thermometer. Four of these tubes were then coated with coloured materials as follows:—

1. Bitumastic paint to give a black cover
2. Entwas budding wax to give a yellowish cover
3. Green paint
4. Limewash to give a white cover.

The tubes were then exposed to the sun on a white cotton wool base; the protruding thermometers were carefully shielded from sunlight.

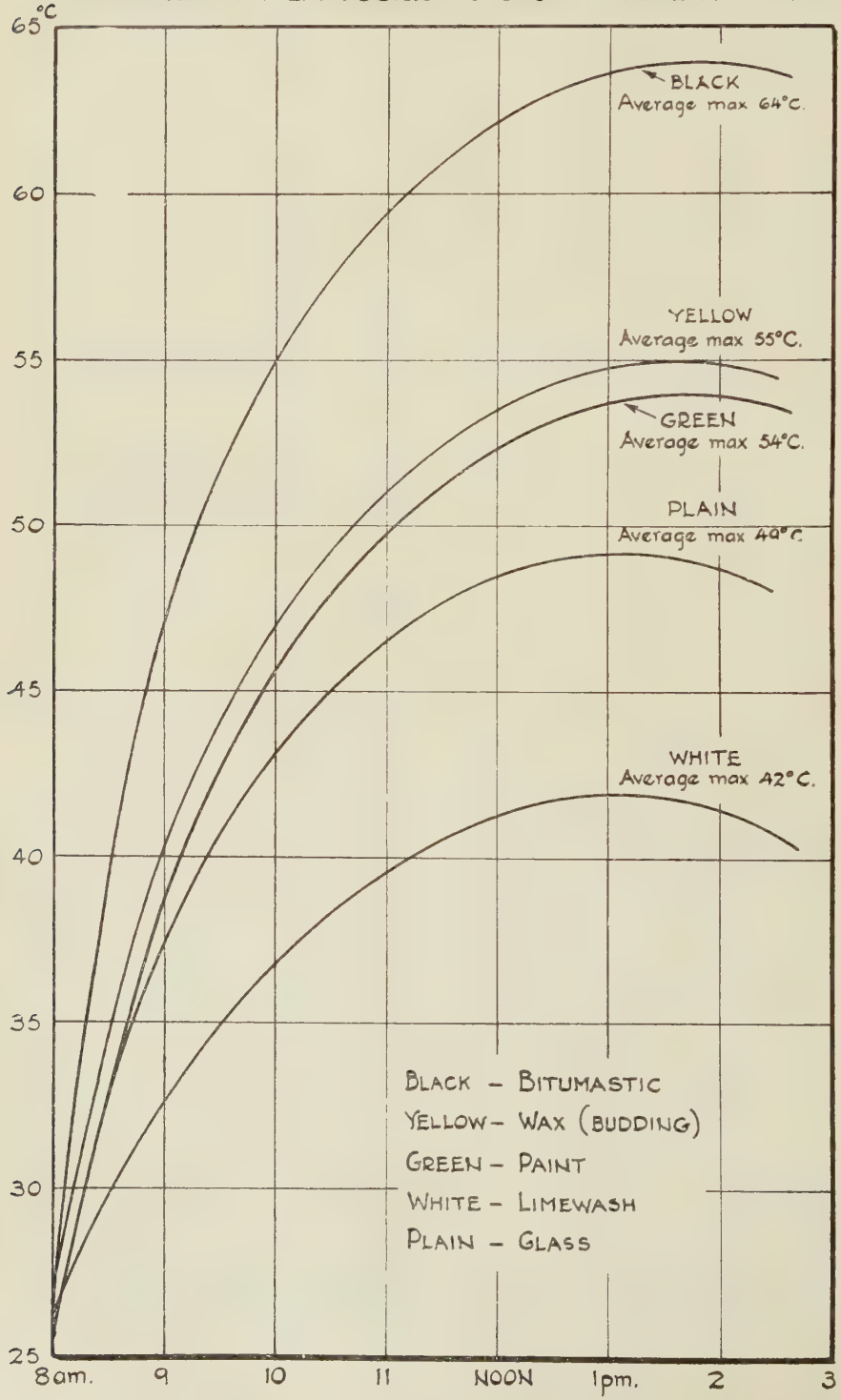
The graph below shows the curves of mean temperatures in degrees centigrade per hour. Readings were taken each hour from 8 a.m. to 2 p.m. over a period of about six weeks. It will be observed that, whereas the water in the limewash-covered tube reached an average maximum temperature of only 42°C, that in the black tube reached an average maximum of 64°C at about 1.30 p.m. When the sun shines continuously throughout the day, temperatures of over 70°C in the black tube have been recorded. These high temperatures indicate that it is not advisable to apply asphalt or tar mixtures to the panel or pruning wounds of rubber trees unless adequate shade is obtainable.

Branch Disease

Pink Disease *(Corticium salmonicolor)*

The situation in regard to this disease remains similar to that of last year. Inland, in the belt of rubber near the foot of

TEMPERATURES RECORDED IN WATER IN 1¼" TEST TUBES COLOURED ON EXPOSURE TO DIRECT SUNLIGHT IN K.L.



the main hills, this disease continues to appear and almost constant treatment is necessary.

In other districts young clearings of budded rubber are frequently attacked. As the immature bark will not stand the application of a strong fungicide such as tar, Noxo or Dougalite it is recommended that water-miscible fungicides, such as those used in the control of Mouldy Rot, should be applied to those affected stems and branches which do not bear a thick, brown mature bark.

Leaf Disease

Leaf Mildew *(Oidium Heveae)*

Owing to the abnormal climatic conditions during the early months of the year the wintering and refoliation period was delayed and extremely prolonged, resulting in a very widespread occurrence of Oidium leaf disease, though the heavy rains, by increasing the vigour of the trees, prevented serious leaf-fall.

In Malaya during January, when the leaves of rubber trees should normally commence to change colour, abnormally heavy rains were experienced, as a result of which wintering was not only delayed but, in many districts, a comparatively high percentage of trees did not look like wintering for some months. The weather brightened considerably in February and some of the rubber on the steeper foothills at once began to winter and by early March had obtained a crown of new healthy foliage. In the first few days of March, however, the weather became dull with heavy mists, low cloud and frequent rain during the middle of the day. Under these conditions wintering, after having made a late start, was again delayed so that not only was wintering irregular and patchy in different districts but individual fields contained trees in various stages of wintering and refoliation, and many instances were observed where trees over 20 years old had put on new growth and terminal whorls of leaves before shedding the old leaf. This unseasonable weather continued throughout March and April except for a fine spell with only occasional showers between March 24th and April 5th.

Very few cases of serious leaf-fall were reported and these concerned only small areas on poor soil. The majority of reports described the outbreaks as very mild. Even in Negri Sembilan and Malacca, where infection was heavy, comparatively little leaf-fall took place, while the foliage generally was considerably better than in recent years. Other districts, however, reported leaf-fall where, in previous years, no leaf-fall had been noticed; for example

Kedah, where wintering is usually severe had, owing to the rain, a very prolonged, indefinite wintering season with consequent growth and development of the mildew fungus, so that in some fields of the older-planted districts the foliage was rather poor. Similarly, West Pahang suffered a very late, prolonged wintering in dull weather and a considerable fall of leaf took place on the poorer areas. Selangor and Perak had a similar mild attack which again could be attributed to the dull showery weather retarding the development of the young leaf.

The rainfall figures in certain centres for the first five months of the year are as under:—

Rainfall, 1934

(inches)

District	Jan.	Feb.	March	April	May	Total
Kuala Lumpur, Selangor ...	11.08	9.00	14.00	15.52	4.00	53.60
Sitiawan, Perak ...	11.62	4.49	14.13	3.32	3.17	36.73
Port Dickson, Negri Sembilan ...	6.47	1.00	11.11	9.00	6.16	33.74
Tampin, Negri Sembilan ...	7.00	5.11	10.00	9.43	4.41	35.95
Malacca ...	8.06	3.79	11.74	4.31	7.43	35.33
Kluang, Johore ...	25.36	8.00	15.62	10.20	2.75	61.93

Throughout the refoliation season tours were made through the various districts and a comprehensive report of the leaf-mildew situation was prepared, the summary of which is as follows:—

During the 1934 wintering and refoliating season, several factors have played a part in influencing the occurrence and severity of leaf-fall caused by *Oidium Heveae*.

1. Excessive rains throughout the country in January and February delayed the commencement of wintering.

2. Dull wet weather in March and April retarded the wintering and refoliation in a very uneven manner, giving much variation in state of foliage from field to field.

3. Lack of sunshine in March and April retarded the maturation of the new young leaves which remained for a long time in the limp condition in which they are susceptible to attack by the mildew fungus.

4. Dull showery weather reduced the day temperatures and increased the humidity, thus favouring the growth and spread of

the fungus (see *R.R.I. Journal*, Vol. 4, No. 2, "Effect of Meteorological Factors on the Virulence of *Oidium Heveae* in Malaya").

5. The rain increased the vigour of growth of the leading stems and leaves so that leaves up to six inches long were observed bearing a thick felt of fungus on the underside of the midrib region.

6. The similarity of weather conditions and prolonged wintering throughout the various districts gave the fungus a chance to develop sufficiently to cause a mild fall of leaf in practically every district in Malaya.

The general distribution of the fungus throughout Malaya has been known for some years but it was not until this year (1934) that its presence in many districts was indicated by a fall of young leaf. In previous years the chief effect of the fungus has been on the inflorescence, resulting in loss or complete absence of seed. Continuous wet weather, as experienced this year, is also unfavourable to flowering and seed-setting, independent of any attack by *Oidium Heveae*. The flowers fail to mature, rot and drop without apparent fertilisation.

Sulphur-Dusting in Control of *Oidium Heveae*

During the season some 25,000 acres were to have been dusted but, owing to the inclement weather, it was practically impossible to keep to the programme so as to give one round of treatment every seven days. Very frequently, sulphur applied during the morning would be to a great extent washed off by heavy rain soon after midday, and it is doubtful whether any prophylactic effects would result. Further, the inability to dry the sulphur and the unreliability of the type of machine most generally used added greatly to the difficulties experienced by the managers of the estates carrying out the treatment.

The results of treatment, generally speaking, indicate a 50 per cent control of the disease by sulphur-dusting. This is fairly satisfactory considering the bad luck which these estates had with their machines, the wet sulphur and the unseasonable weather.

There are no results to hand which indicate any likely increase in yield of rubber from sulphur-dusted trees.

Insect and Animal Pests

White ants (*Coptotermes curvignathus* Holmgr.)

This insect pest continues to give much trouble in areas of young rubber. The intelligent, communal, underground life of

these insects makes them a particularly difficult pest to control. Their ability rapidly to increase their numbers at will renders treatment by poisons almost futile and, if an attack of trees in a certain area fails to yield to treatment, little remains to be done except to trace the termite galleries and find the nests, making certain that the nests are lifted out carefully and all termites and larvae completely destroyed. It is useless merely to break up and scatter the nests as they may re-form within twenty four hours. Regular inspection at monthly intervals is strongly advised if this pest is to be kept under control.

The Cockchafer-Grub *(Psilopholis grandis)*

During the year three new centres of infection have been reported, but the affected areas are small and the pest appears to be satisfactorily kept in check by natural predators. In view of the interest taken in this pest the following notes may be appropriate. I am indebted to Mr. G. H. Corbett of the Department of Agriculture for much of the information contained under this heading.

The grub of this beetle (or closely-related forms) has been found damaging young rubber roots in Java, Borneo, Ceylon and Malaya. Mature rubber areas infested with this grub have been located in Perak, Selangor and Negri Sembilan.

Though normally an inhabitant of the jungle the beetles occasionally fly out into the less shady rubber plantation, fall to the ground, crawl to the shade of the cover plant and lay their eggs in the soil. The eggs then hatch to produce the young grubs, which burrow through the soil and feed indiscriminately on roots of any plant encountered. In this way patches of cover plants, rubber seedlings, bracken and other natural cover may be observed in a wilted condition, and can be lifted up or pushed over with ease owing to the grubs having eaten away all tissues below ground level; this causes the soil to become very spongy.

Rubber roots of greater diameter than 1/3 inch are not usually killed but the bark may be pitted or in parts completely removed.

(a) *Organism*

Psilopholis grandis, a species of the cockchafer family *Melolonthini* a sub-family of *Melolonthidae* of the order *Coleoptera.*

(b) *Life History*

The large cockchafer beetles may be observed during February and March in known infested areas to be on the wing at dawn for about a quarter of an hour and again at dusk for a short time, meanwhile resting in shade on the soil surface.

The eggs, white ellipsoid bodies, are deposited in groups of about 34 at a depth of 6—12 inches below the surface of the soil. Open friable soils, having a high content of organic matter, are more favourable to their development.

The eggs are incubated in the soil for about 14 days and the larval or grub stage begins. These tiny white grubs then begin burrowing through the upper 12 inches of soil devouring any roots they may come across, making the ground quite spongy. The larvae increase in size and soon assume the typical white grub appearance. The grub has three pairs of strong legs, a brown head and a large white body of which the abdominal segments are enlarged causing a typical arching of the bark, the ventral portion being curled under. The grub or larval stage lasts for about 310 days. They then become inactive and pupate at a depth of about nine inches in the soil. The true pupa stage lasts for about 22 days, when an inactive young beetle is produced which after about ten days becomes active and emerges from the soil as a brown beetle, 1—1½ inches long, to find a mate, and the life-cycle begins over again. The full life-cycle covers approximately one year but as the stages overlap it is possible to find several stages in the soil at any given time.

The following appears to be the general life-cycle:—

State	*Period*	*Season*
Egg	14 days	January—February
Larva	311 days	February—December
Inactive Larva	7 days	Mid-December to Mid-February
Pupa	22 days	do do
Inactive Beetle	11 days	do do
Active Beetle	28 days	January—March

(c) *Control*

No satisfactory method of control has yet been found, attractants and traps having proved unsuccessful. Spraying of food plants upon which beetles feed, and the application of soil insecticides are uneconomic in practice. Wild pig will eat both grubs and beetles and will control the pest to a certain extent.

To prevent excessive damage of rubber roots by this pest it is suggested that alternative food-plants should be encouraged and a cover of fallen leaves established. Another method of control involves the use of indigenous parasites of which two are known to occur in Malaya, *viz.* the Scoliid wasps, *Campsomeris pulchrivestita* and *C. iris* (or *C. tristis* Sauss.) It is possible that if these wasps were bred in large enough numbers and liberated in grub-infested areas a fair amount of control would be obtained. This wasp, however, is itself parasitised by a *Bombyliid* hyperparasite *Hyperalovia tantalus* F. which to some extent prevents its rapid development under natural conditions. Observations and counts of collections of grubs from various areas indicate that these wasps effect about 25 per cent control over the cockchafer-grub pest.

Caterpillars

Various small, more or less hairy caterpillars, continue to appear in certain localities upon the leaves of cover plants and natural undergrowth. These caterpillars, which usually belong to the family *Lymantriidae,* may damage the covers to a considerable extent but rarely attack the rubber trees. In mature rubber the caterpillars may sometimes become a nuisance in that the poisonous spines or hairs cause irritating sores on the legs of the labourers.

As a rule these outbreaks of caterpillar pests are very local and of a temporary nature so that control by poison sprays is not recommended.

Beetles

Several cases of damage to cover plants by beetles have been reported and two were found damaging *Melastoma* sp. The chief beetles found were *Haltica cyanea* and *Dimax angulicollis* Clk. but as their activities seem to be confined to the one cover plant, the rubber not being attacked, no control measures were undertaken.

Another beetle, *Aphanocephalus 4—maculatus,* was however observed to attack the tapping panel immediately after tapping, causing slight wounds just above the tapping cut. Two or three applications of one of the Mouldy Rot fungicides apparently quickly repelled this very tiny insect from the bark.

Spider Pest

As in 1933 this pest has done considerable damage to the foliage in young areas often in conjunction with *Helminthosporium*

sp. and *Gloeosporium* sp. and, in several observed cases, with *Oidium Heveae*.

The leaf mite *Tarsonemus translucens*, the scale insect *Lecanium* sp., and the bag-worm *Acanthopsyche snelleni* also attack rubber trees up to a considerable age. A familiar sight in many budded clearings up to six years is the numerous conical cocoons of the bag-worm standing out almost at right angles from the bark surface. It appears to do little damage on untapped bark but may become very troublesome on the tapped panels.

Snails

Several reports were received during the year of snail or slug damage to young seedlings and buddings. The snails appear to feed upon the buds and, if the snails are not controlled, the stem continues to produce fresh buds which are again broken into by the snails. Continued growth of these damaged buds produces a distinctive type of fasciation.

Rodents

Under this heading come chiefly rats *Mus* sp., squirrels *Sciurus vittatus* Raffl and porcupines *Hystrix javanica*, the latter apparently coming in from the jungle or uncleared ravines now that the popularity of natural covers has provided the necessary shelter within the rubber plantations.

While the damage done by squirrels and rats is usually confined to young branches and newly-tapped bark of rubber trees, that of the porcupine may extend well into the bole of the tree, and roots up to three inches diameter may be gnawed through. Hunting and elimination of the breeding places is the only effective method of control.

Suitable baits for control of the smaller rodents were mentioned in the *Annual Report 1933*, p. 118.

Bacteriology of Latex

During the last quarter of the year certain work on the bacteriology of latex was undertaken in conjunction with the research on latex preservation being carried out by the Chemical Division, the object being to find out what happens to the latex organisms during preservation, and especially during the early stages of preservation.

After preliminary trials with various culture media it was found that D.I.F.C.O. Bacto Dextrose agar gave the best results both from the point of view of highest count and quickest develop-

ment, the plates being easily countable after three or four days incubation at room temperature (27°C-30°C.)

Several samples of unpreserved, fresh field latex were examined for numbers of bacteria per cubic centimetre at various times of the day up to the point of flocculation of the latex; the following is a typical example.

	per c.c.
At 11.15 a.m. latex gave a bacterial count of ...	6,000,000
At 11.30 a.m. latex gave a bacterial count of ...	60,000,000
At 1 p.m. latex gave a bacterial count of ...	400,000,000
At 2 p.m. latex gave a bacterial count of ...	2,000,000,000

After this time flocculation had set in so that the latex would not pass through a pipette. The latex had a distinct putrefactive odour at this stage.

Meanwhile a considerable amount of work in the Chemical Division had shown that most of the disinfectants were useless for the preservation of fresh latex. Dr. Rhodes had, however, made the important discovery that, with the addition of a small amount of ammonia—about 1/5th of the usual amount required to preserve latex—a few of the bactericides could be made to preserve latex but were required to be present in greater concentrations than would be required in a liquid medium other than latex.

Dr. Rhodes suggests that this is due to the adsorption of the disinfectant by the rubber phase. Accordingly, three flasks of latex were preserved as follows.—

(a) 1 per cent Anthral + 0.12 per cent Ammonia
(b) 0.5 per cent FD4 + 0.12 per cent Ammonia
(c) 0.69 per cent Ammonia.

The original latex was similar to that of which counts were given above. The latex was always shaken for five minutes before extracting the 10 c.c. for dilution purposes. Plating was carried out usually about noon on Bacto Dextrose agar and dilutions varied from one ten-millionth to one hundredth as required. A similar set of three flasks were made up to confirm the results obtained from the first set. In both sets the original enormous multiplication of bacteria in the preserved latex was demonstrated beyond doubt, as also was the repeated bursts of growth in the "Anthral" latex, which took place after the latex has apparently become sterile. Putrefactive odour always accompanied the rapid growth of the organisms, the odour passing away again on the advent of apparent sterility.

From the results obtained it would appear that the bacteriolytic action of ammonia is complete in five to eight days, the latex

becoming completely sterile after this time. The maximum development of bacteria is also least in the flask preserved with 0.69 per cent ammonia, but even so is close to the number at which unpreserved fresh latex has developed putrefactive odour and begun to flocculate. The latex in the flask containing FD4 showed complete bacteriolytic action in 10 days and thereafter remained sterile, similar to the ammonia-preserved latex. Its maximum development on the second day of 3,000 million bacteria is 50 per cent more than the maximum found in the fresh latex at the point of flocculation. The putrefactive odour present at this stage, though distinct, is much less intense than that of fresh latex at the point of flocculation.

The flask containing Anthral proved extremely interesting. The enormous count of 18,000 million bacteria on the third day, i.e. after a lapse of 48 hours, with a reduction to 80,000 on the 10th day, suggests not only a bacteriolytic action but also an autolytic action which again is supported by the frequent bursts of growth on the 2nd, 14th, 31st, 43rd, and 55th days. The Anthral gradually reduces the vigour of the organism until final sterility is produced after 70 days.

Two species of organisms were solely responsible for these high counts and have been isolated; one is a vigorous growing orange-coloured organism, the other a vigorous lemon yellow, slimy organism. Several other less common and less resistant organisms have also been isolated.

A similar flask containing FD4 and latex obtained later in the day prepared by Dr. Rhodes, became putrefactive and coagulated after one month's storage in the laboratory.

It would appear that the presence of 0.12 per cent ammonia in the latex prevents coagulation despite the large increase in the bacterial numbers during the early storage of preservation.

More recently Dr. Rhodes prepared several tubes of latex preserved with cyanide of mercury $Hg(CN)_2$, with no added ammonia, which after three days' storage gave bacterial populations as follows:—

	per c.c.
$Hg(CN)_2$ 0.05 per cent on 3rd day gave a count of	41,000 bacteria
„ 0.1 per cent on 3rd day gave a count of	4,500 bacteria
„ 0.2 per cent on 3rd day gave a count of	3,300 bacteria

Both samples of latex containing the higher concentrations of $Hg(CN)_2$ were in good condition. A 500 c.c. flask of latex preserved with 0.1 per cent $Hg(CN)_2$ without addition of ammonia was then examined for bacterial numbers. The counts for the first day and each of three successive days were 650,000 per c.c., 21,000 per c.c., 9,000 per c.c., and 2,300 per c.c.; after the fourth

day the latex became sterile and has been stored for several weeks.

These counts are surprisingly small for the first few days of preservation. No putrefactive odour was noticed, in fact the latex had a particularly sweet odour.

It is worthy of note that FD4 consists of about 10 per cent of an organic mercury compound. Other mercury salts are to be tested and will be reported on later.

A striking fact brought out during the investigations has been the remarkably different behaviour of the three bactericides when added direct to solid culture media which was innoculated with the two most common and persistent organisms found in latex.

Anthral was shown to be effective in preventing growth in agar media at 0.075 per cent strength, FD4 at 0.1 per cent strength, while in latex ten times these strengths is required. With ammonia however, it is found that 1.4 per cent is required to prevent growth in agar medium or twice the strength normally used for the preservation of liquid latex.

Effect of delayed Action due to low Temperatures

The effect of the time factor on the efficiency of latex disinfectants was interestingly demonstrated by use of a cold chamber at about 5°C. FD4 was added to latex in various quantities kept in a Frigidaire for three days at 3-6°C after which time platings were made and the tubes returned to the cold chamber. The amount of bactericide and the counts obtained are as follows:—

(1) 0.2 per cent FD4 gave a count of 10,900,000 per c.c.
(2) 0.35 per cent FD4 gave a count of 5,000,000 per c.c.
(3) 0.50 per cent FD4 gave a count of 3,600,000 per c.c.
(4) 0.60 per cent FD4 gave a count of 1,000,000 per c.c.
(5) 0.75 per cent FD4 gave a count of 100,000 per c.c.
(6) 1.00 per cent FD4 gave a count of zero per c.c.

After a further three days in the cold chamber Nos. 1 and 2 flocculated and coagulated in 3-4 days. No. 3 showed a distinct dull cream, was slightly putrefactive and later flocculated. Nos. 4, 5 and 6 remained sweet for two months. The use of low temperatures has therefore been successful in assisting latex preservation by bactericides. It would appear that the cold had delayed bacterial activity and thus given the bactericide time to act. This time reaction for such powerful germicides as FD4 and Anthral is difficult to understand, except on the theory of rubber

phase adsorption. Ammonia though not present in sufficient quantity to delay bacterial activity, serves to neutralise the acid products of such activity, thus preventing premature coagulation.

Effect of Heat on fresh and preserved Latex

Although the effect of heat on fresh latex was already known, tubes of latex were subjected to heat with results as follows:—

1. Pasteurisation at 70°C for one hour resulted in an apparently good latex, but a few days later the latex became putrefactive and coagulated.

2. Boiling in a steam bath brought on coagulation within one hour.

3. Sterilisation in an autoclave for one and a half hours at 14 lb. pressure proved to have effected complete coagulation.

The effect of similarly heating latex preserved with ammonia was then considered and, realising that heat would tend to drive off the ammonia, tubes containing 10 c.c. each of latex preserved with excessive quantities of ammonia, ranging from 1 to 2 per cent, were prepared. These were autoclaved at 14 lb. pressure for half an hour, the total heating time being 70 minutes. After three months' storage in the laboratory, the latex in the tubes is in a good state of preservation. Creaming or thickening, however occurs on long standing.

By the use of emulsifiers and stabilisers such as triethanolamine oleate and glycerine when added in quantities to form one per cent of the latex it was found possible greatly to reduce the amount of ammonia necessary to maintain fluidity during heating. Samples of latex preserved with 0.3 per cent of ammonia plus 1 per cent triethanolamine oleate or 0.4 per cent of ammonia plus 1 per cent of glycerine were autoclaved successfully at 14 lb. steam pressure and later stored for three months, after which, except for slight sedimentation and creaming, they were in a good state of preservation.

A range of concentrations of the various materials were tried, the results of which will appear in a more detailed report later.

Lectures

Lecturer	*Title of Lecture*	*Venue*
R. P. N. Napper	New Theories of Root Disease	Central Perak Planters' Association, Ipoh
F. Beeley	*Oidium Heveae* Leaf Disease, preceded by demonstrations of dusting	Incorporated Society of Planters, Tampin-Jasin Branch, Jasin

F. Beeley	*Oidium Heveae* Leaf Disease	Incorporated Society of Planters, Kuala Lumpur
R. P. N. Napper	Root Disease Control	Incorporated Society of Planters, Tampin-Jasin Branch, Jasin

Demonstrations

Demonstrator	*Object*	*Place*
F. Beeley	Dustejecta Machine by Messrs. Guthrie & Co., Ltd. The demonstration was followed by a short address, after which numerous questions were answered	Labu Estate, Negri Sembilan
F. Beeley	New Sulphur Dusting Machine "Tornado Power Dry Sprayer"	Atherton Estate, Negri Sembilan
F. Beeley	Modified type of the Dustejecta machine	Puchong Estate, Selangor
F. Beeley	Sulphur dusting to test the modifications of the machines to suit Malayan conditions	Pataling Estate, Selangor
F. Beeley	Four types of machines, followed by a lecture on *Oidium Heveae*	Incorporated Society of Planters, Tampin-Jasin Branch

Publications

(1) Experiments in Control of the Termite Pest of Young Rubber Trees
R.R.I. Journal, Vol. 5 no. 2 by F. Beeley

(2) *Oidium Heveae*—Report on the 1934 Outbreak of Hevea Leaf Mildew
R.R.I. Journal, Vol. 5 no. 4 by F. Beeley

(3) Pamphlets entitled "Practical Hints on Sulphur Dusting" by F. Beeley

(4) Circular on "Brown Bast" by F. Beeley

(5) Circular on "Mouldy Rot of the Tapping Panel" by F. Beeley

Tours

(1) Negri Sembilan and Malacca (13th to 19th March) by F. Beeley

(2) Perak and Kedah (11th to 14th April) by F. Beeley

(3) Johore (1st to 9th December) by R. P. N. Napper

F. Beeley
Pathologist

Kuala Lumpur
7th March, 1935

APPENDIX

In addition to the correspondence included in the appendix to the Director's report, the following specimens have been received for examination:

Budded stumps	7
Plants and shoots	8
Leaves	127
Branches	—
Bark	20
Roots	16
Insects	10
Miscellaneous	31
Tree trunks	2
Total	221

Total Number of Visits	191
Total Number of Interviews	58

ANNUAL REPORT

CHEMICAL DIVISION

Staff

Until the last two months of the year, Dr. Rhodes, Dr. Wiltshire and Mr. Hastings were available for duty and during the first six months Mr. Bishop and Mr. Moore, the officers of the Technological Division, assisted the Chemical Division by dealing with the majority of its advisory work. In August, Mr. Moore was attached to the Chemical Division in the capacity of advisory officer. Mr. Sekar was absent on leave from 23rd April to 10th August, and a good deal of routine laboratory work fell to the lot of Mr. Hastings with consequent reduction in his available research time.

By the death of Dr. Wiltshire on 13th November the Division received a blow from which it will not easily recover. The Institute lost thereby an officer of first-rate ability and every worker in the Division lost a friend.

Latex Constituents

It has not been possible, owing to the pressure of other shorter-range but none the less important activities, to give serious attention to the separation and characterisation of new latex constituents. Supplies of quebrachitol have been kept available against requests for the material by workers in other spheres of scientific activity and it has been possible to give assistance to a few interested persons. It is interesting to record that Imperial Chemical Industries Ltd., to whom small supplies of pure quebrachitol were provided by us, have recently developed and patented a process for the manufacture of a thermoplastic substance derived therefrom. It cannot yet be predicted with certainty whether the cost of quebrachitol will preclude its use in the manufacture of moulded articles, but it is probable that the cost will prove to be too high. It is possible however that crude serum evaporate may be almost as satisfactory as pure quebrachitol in the manufacture of this thermoplastic substance and in that event such crudes could be made available at a much lower cost. This matter will be investigated in the coming year.

Latex Preservation and Concentration

General

The markets for preserved and concentrated latex have continued to expand. It was predicted in the last report that

buyers' requirements would become more exacting during the year under review, and this has proved to be the case. Complaints against discolouration, low stability and putrefactive odour have been frequent and producers have this year been penalised more often than in the past for low dry rubber content. It is possible that the latex of the near future will be required to satisfy a number of tests which will include colour and odour as well as dry rubber content and alkalinity. The exercise of the very greatest care in collection and preservation will in that event be imperative.

Colour of Preserved Latex

Enquiries into the causes of this defect were proceeding last year but they had by no means reached finality by the end of 1933. During the current year the great attention which was paid to the problem resulted in the publication of an article which it is felt describes accurately the causes of discolouration as being due to the formation of iron sulphide in the colloidal and amorphous forms within the latex. The iron may be derived from collecting pails and iron primary transport vessels, as a result of attack by lactic acid which is itself formed in the latex by partial putrefaction before ammoniation; it may also be derived from the iron shipment drums or tinned iron containers by slow alkaline corrosion after ammoniation. Slight putrefaction produces also traces of hydrogen sulphide which in presence of ammonia reacts with dissolved iron, producing thereby the dark coloured sulphide to which objection is taken. The estate manager is at present unable to prevent the contact of iron with the ammoniated latex in the shipment vessels and the slow resultant alkaline corrosion, but much can be done by him to minimise the danger of discolouration by ensuring the scrupulous cleanliness of all utensils, by early and rapid collection and by the use of a small amount of ammonia in the field. In the wintering season latex is particularly prone to rapid putrefaction in the field and during this period, and also at times when subsidiary bursts of growth are taking place as a result of rains after a fairly prolonged dry period, the use of ammonia in the field is particularly important.

Internal Treatment of Shipment Vessels

During the year a large number of different paints and corrosion preventives have been tested in order to determine their suitability for the internal treatment of latex drums against attack by the products of putrefaction of latex and against the attack of ammoniated latex itself. The method which has been adopted for

testing the value of a coating is that of immersing a strip of painted or coated metal in fresh latex and allowing slight putrefaction to take place for four hours. After this period the latex is ammoniated and the painted strip is allowed to remain in the ammoniated latex for a period of six weeks. Unpainted metal strips are used as controls and are given identical treatment. During the immersion period periodical examinations are made for degree of discolouration. At the end of the test, the painted strips are washed and the paint examined for continuity and toughness.

Attempts to induce "passivity" in bare metal by pickling with strong ammonia and other substances proved unsuccessful.

The types of paints and coatings examined, have included preparations, proprietary and otherwise, consisting essentially of

(i) bitumen
(ii) chlorinated naphthalenes
(iii) soluble bakelite
(iv) chlorinated rubber
(v) proprietary paints of which the main constituent was not known with certainty
(vi) latex and rubber solutions compounded with zinc oxide.

The tests have indicated that preparations of bitumen are in general unsatisfactory. In nearly every instance these paints dry much too slowly and discolouration develops in practically all cases despite the presence of the protective layer. In many cases the film shows defects after immersion. Chlorinated naphthalenes have similarly not given satisfactory results in our hands either alone in solution or when mixed with solutions of bitumen. Proprietary paints consisting of soluble bakelite have not given wholly satisfactory results. In the transparent uncompounded forms they do not prevent discolouration entirely and the film tends to break away from the metal after long immersion; a similar bakelite preparation containing pigment is, however, reasonably satisfactory, though expensive. None of the proprietary paints of unknown composition have proved really satisfactory. Preparations of chlorinated rubber, whether proprietary or compounded in the laboratory from "Pergut" with suitable solvents, softeners and other ingredients, have given excellent results in our tests. These preparations dry quickly on the metal, prevent discolouration and are not badly affected by long immersion in latex. A manufacturer of latex drums is showing an interest in a proprietary brand which has been under test and it is hoped that in the coming year new latex drums with an internal protective film applied before assembly will become available.

Many estates ship latex in second-hand drums, the internal treatment of which is for obvious reasons difficult; a paint which dries slowly in free air is obviously unsuitable for use in an empty drum; treatment with paint involves in most cases pouring into the drum a large amount of paint, applying it to the inner surface by rolling the drum and finally pouring out excess paint. This is an expensive and wasteful procedure, but on most estates this would be the method adopted. A very cheap medium and one which is comparatively easy to apply is called for in such cases. The simple expedient of applying a latex film to the metal has been shown to be unsatisfactory, but laboratory trials with ammoniated latex to which had been added 20 per cent by weight of zinc oxide, have given encouraging results. A large shipper of latex has kindly consented to make experimental shipments of drums treated with this medium and results will be awaited with interest.

Putrefactive Odour in preserved Latex

Buyers have complained frequently during the year against putrefactive odour in consignments of preserved latex and against the lack of a simple chemical test by which to judge the intensity of the putrefaction which may have taken place. At present the only test is by the nose and arbitrators who are called upon to apply this test, naturally differ in their opinions when judging samples in which the degree of putrefactive odour is very slight. Preliminary attempts have been made at the Institute to develop a simple chemical test upon the results of which arbitrators might come to decisions without reliance upon the sense of smell. The problem is by no means a simple one; the objectionable odour may be caused by a number of different substances and in any one sample of latex the smell may be due to one or a number of them in varying proportions. A single simple test for the degree of intensity of odour is therefore by no means easy to develop and a satisfactory test cannot yet be recommended.

Immersion tests with silver foil on a number of latex samples chosen for diversity of smell "types" and for degree of odour intensity, indicate that, while in many cases the degree of discolouration produced on the foil in a given period does bear some relation to the intensity of the putrefactive odour, this is not universally the case and it frequently happens that a latex which possesses quite a strong and objectionable odour reminiscent of substances of the type of butyric acid will yield only slight indications of discolouration on silver foil. Similar results were obtained with moist lead acetate papers suspended above the

surface of latex in closed containers. Mercuric chloride when added to latex in small proportions and allowed to stand gave deposits of which the amounts could not be taken as representative of degree of putrefaction as judged by the nose. Reagents used for the detection of amino acids also gave misleading results; this was not unexpected in view of the fact that many of them also react to ammonia. Tests for bodies of the indole and skatole type were also found to be inapplicable.

Work on this problem will proceed as opportunity offers.

Preservation tests with varying amounts of ammonia, on latex collected early under estate conditions much better than average, have indicated that, with ammonia contents only slightly below but of the order of 0.5 per cent, an appreciable odour may develop within six weeks. The indication is that an ammonia content of 0.5 per cent allows little or no margin of safety against this defect; buyers who object to traces of putrefactive odour, and estates which are free to exceed this amount of preservative would do well to consider the use of 0.70—0.75 per cent ammonia in preservation. This conclusion receives support from chemico-bacteriological work which is proceeding in collaboration with Mr. Beeley of the Pathological Division. Bacteria counts on latex preserved with small amounts of ammonia in conjunction with disinfectants indicate that a latex which is at one period apparently sterile, may within a few days show high bacteria counts when plated out on nutrient media; the phenomenon is similar to that known as "bacteriolysis". Still later, it may again re-assume a state of apparent sterility. From the preliminary observations which have already been made, there is reason to suppose that putrefactive odour is probably due in large measure to the successive bursts of growth which may take place in the latex bacteria. So far, observations on field latex preserved with 0.7—0.75 per cent ammonia have indicated that, once an apparent state of sterility has been reached, these further bursts of growth do not occur, and the latex has remained free from putrefactive odour for periods of over two months.

Film Strength Test for preserved Latex

This test has been proposed by the Dunlop Rubber Co. as one which in their experience is likely to give information of value.

In order to be able to form conclusions as to the ease with which this test could be carried out on estates by intelligent Asiatic assistants, latex films were prepared regularly for a period of 2½ months from freshly preserved field latex, from old preserved latex and from centrifugal concentrate and creamed latex, by two

different assistants. The experience was that under conditions in which old latex, centrifugal concentrate and creamed latex gave good smooth films having thicknesses which were satisfactorily uniform and within the tolerance limits, freshly preserved field latex gave considerable trouble. Almost every film showed long irregular crevasse-like cracks. In Malayan estate practice it would be necessary for tests to be carried out on the freshly-preserved material and it seems at present that the preparation of good films would require laboratory resources and refinements of technique which are beyond the scope of most Malayan producers.

Specific Gravity of preserved Latex

Although various authors have published values for the specific gravity of fresh latex, little attention appears to have been paid to the preparation of a specific gravity table for preserved latex over a wide range of dry rubber contents. The examination of a large number of samples of preserved latex was completed during the year. The samples covered a wide range of dry rubber contents and a specific gravity table has been published which gives the specific gravity of an average preserved latex of any dry rubber content. From the available figures it was also possible to deduce a value of 0.902 for the specific gravity of the rubber phase of latex and this figure is in close agreement with that of Scholz and Klotz whose value differed appreciably from that previously obtained by de Vries. Preliminary figures were also recorded for centrifugal concentrate and it was shown that these are approximately 0.005 lower than would be predicted for a preserved field latex of similar dry rubber content.

Viscosity of Latex

Late in the year a new form of viscometer, namely the "Höppler" was brought into service. This instrument can be employed for latex of all concentrations and gives results in absolute units. The viscosity of a range of samples of latex preserved with varying amounts of ammonia have been studied in order to explore the effects of latex putrefaction on this physical property. The results to date indicate that, where the amount of preservative is inadequate for long period preservation, the development of putrefactive odour becomes apparent before changes in viscosity become detectable; in cases where the amount of preservative is almost but not quite adequate, putrefactive odour may be very pronounced for several days before a rise in viscosity presages the formation of clots.

During the coming year a wide range of samples of latex will be examined and it is hoped as a result to publish a D.R.C.-viscosity table for preserved latex.

Alternative Methods of Preservation

During the year it has become increasingly evident that a latex preserved with little or no caustic alkali, might be welcomed on the latex market, and accordingly close attention has been paid to the problem of finding a substitute for the almost universal preservative, ammonia. There was already evidence that the problem is more difficult than it would at first appear; a number of powerful disinfectants have been tested with disappointing results and it was deemed advisable to study the effect of likely preservatives on the bacterial population of the latex which it was sought to preserve. A valuable and productive collaboration was commenced with Mr. Beeley of the Pathological Division, and the bacterial studies have thrown much light on the reasons for the failure of numerous disinfectants.

It was felt that some of the materials which were unsatisfactory when used alone at room temperature in fresh latex might prove effective if assisted by the presence of a small amount of ammonia and tests have shown that such is the case. In the early experiments the following materials were found ineffective at room temperature in fresh latex and also in presence of 0.1 per cent ammonia, when applied where possible in amounts up to 1.0 per cent calculated on the weight of latex:—

Non-proprietary Substances

Sodium fluoride, paranitrophenol, calcium arsenate, lead arsenate, potassium cyanide, mercury benzoate, thymol and cresol.

Proprietary Substances

"Izal", "Killgerm", "T.C.P.", "Abracide", "Lystonol", "Lissapol", "Vulcastab".

The following materials showed some promise when applied at room temperature in amounts up to 1.0 per cent to latex containing 0.1 per cent ammonia:—

"Anthral", "F. D. 4".

It was found that, in order to achieve preservation for periods of about two weeks, it was necessary to employ amounts of

"Anthral" of the order of 1.0 per cent; with F.D.4 the minimum amount was 0.5 per cent. Anthral and F.D.4 should prove toxic to bacteria when applied in amounts much smaller than this and it therefore seemed possible that the effectiveness of the disinfectant was reduced in latex by adsorption on the rubber phase or by some similar phenomenon. Bacteriological examinations were made of latex preserved as under:—

(a) latex with 0.1 per cent ammonia plus 1.0 per cent Anthral
(b) „ „ 0.5 per cent F.D.4
(c) latex with 0.7 per cent ammonia.

This examination revealed that during the first two days of preservation, the bacterial population of the latex increases enormously in all three cases. Subsequently the simple ammoniated latex becomes apparently sterile and so remains. In the case of the two disinfectants an apparent sterility also results at first, but at intervals successive bursts of growth and successive stages of apparent sterility follow. Coincident with these bursts of growth, putrefactive odour is observed and the latex in most cases coagulates after approximately one month. There is here a strong indication that if a sufficiently large amount of ammonia is applied to fresh latex, it exerts a more profound and lasting effect upon the bacterial population than do quite large amounts of certain powerful disinfectants. Ammonia, by virtue of its alkalinity, is able to neutralise the acid produced by the first phenomenal burst of bacterial growth and finally to render the latex sterile. If a non-alkaline disinfectant is to be found for fresh latex, it will require to be extremely quick in its action. The initial burst of growth will need to be prevented otherwise coagulation must almost certainly result. Anthral clearly does not satisfy this desideratum and in any case the pronounced red colour which it imparts to latex would place it beyond consideration as a preservative. The disinfectant F.D.4 is somewhat more effective, since it can be employed in slightly smaller amounts. It is not however by any means ideal. It is strongly alkaline and a chemical examination revealed that it contained, besides an alkaline inorganic substance, a very small amount of an organic mercury compound which was clearly the real agent of sterilisation. A small supply of this body was separated from F.D.4 and preservation tests were made with it and with a range of other compounds in fresh latex which, immediately after treatment with disinfectant, was placed in a refrigerator at a temperature of approximately 5°C. for three days before being withdrawn and stored at room temperature.

The object was to retard the initial bacterial growth, thereby increasing the time available to the disinfectant to bring about sterility before coagulation could result. These experiments were encouraging. Counts of bacteria revealed that growth was very much retarded and the latex has in some cases remained fluid for periods of two months. Further work on these lines is indicated but it is improbable that a procedure of this sort would be practicable for estates.

Following upon the separation of a mercury compound from F.D.4, trials were made at room temperature with it and with other organic and inorganic mercury compounds in fresh latex and also in latex containing a little ammonia. It has not yet been possible to test a very large range of mercury compounds but there is no doubt that they hold distinct promise as preservatives. The most satisfactory mercury compound so far found is mercury cyanide. Bacteriological examination reveals that when present in amounts not exceeding 0.1 per cent, its action is extremely quick in fresh latex and with it and with other mercury compounds it has been possible for the first time to preserve neutral fresh latex at room temperature in a fluid condition for periods of a fortnight. The experiments are still in progress and it is impossible yet to say what the final outcome will be. The work on preservation will continue during the coming year when it is hoped in conjunction with Mr. Beeley of the Pathological Division, to make a fuller publication of the results obtained.

As it is possible that the complete publication may not be available for some time, the present preliminary disclosure is now made

Attempts have been made to preserve latex by full-heat sterilisation and by pasteurisation. Latex containing varying amounts of ammonia up to 0.75 per cent could not be sterilised satisfactorily in the autoclave at one atmosphere pressure because coagulation resulted. It was found necessary to employ a stabiliser before this could be accomplished. For this purpose triethanolamine oleate proved suitable. The minimal amounts for effective sterilisation were 0.2 per cent triethanolamine oleate together with 0.2 per cent ammonia. The sterilised latex remained fluid for periods of over a month but eventually developed putrefactive odour.

Latex containing similar amounts of ammonia and stabiliser was heated to a temperature of 90°C for periods varying from ¾ to 3 hours. The stabiliser Vulcastab A was tested in addition to triethanolamine oleate. The results were not encouraging because in no case did the products remain free from putrefactive

odour and clots for periods of longer than three weeks. The addition of sodium arsenite and mercury salts in amounts of the order of 0.1 per cent to the stabilised latex before autoclaving gives much more satisfactory products. Further work will be carried out on these lines but in view of the fact that sterility is by no means easy to achieve by heat, it is unlikely that a workable estate procedure for heat sterilisation will be evolved.

Latex Concentration

(*a*) *Concentration by Creaming*

During the year the creaming agent Tragon A, which was mentioned in the annual report for 1933 and is marketed by Imperial Chemical Industries Ltd., has been subjected to large scale estate tests and the present indications are that when used under optimum conditions it is more suitable and much less variable than gum tragacanth. The material gives best results when applied as a 3 per cent solution to latex containing 1.0—1.5 per cent ammonia in an amount equal to 0.3 parts of solid gum per 100 parts of the water phase of the latex.

A large range of gum tragacanth samples obtained for us by the London Advisory Committee were tested in freshly-preserved latex. The results were variable and lower than those obtained in London with old ammoniated latex. It has been the general experience that freshly-preserved latex creams less easily than latex which has been preserved for some weeks before creaming. There was no relation between the price of the gums and their value as creaming agents.

It has been found that, in certain cases where it was difficult with gum tragacanth to obtain a cream richer than 52 per cent, the addition of a further amount of gum to the separated cream often has the effect of inducing further creaming. This "boosting" process has been subjected to successful estate trial.

The Superintendent of Laboratories of the London Advisory Committee has forwarded to us samples of two entirely new creaming agents discovered and developed by them. These have been tested on freshly-ammoniated latex. The materials are not quite so efficient as Tragon A but they possess very distinct possibilities.

In last year's report reference was made to a patent for a modification of the gum tragacanth creaming process which had been developed at the Institute. This patent has now been granted and its text will shortly be published in the Institute *Journal*.

Experiments are in progress which are designed to increase the ease with which a 58-60 per cent cream can be obtained. By a pre-treatment of the latex, creams of 62 per cent have been obtained on a laboratory scale. It is possible however that the pre-treatment has harmful effects upon the quality of the final product and until large-scale trials have been made it will be impossible to make any recommendations to estates.

(*b*) *Centrifugal Concentration of Latex*

Towards the end of the year a new type of centrifuge was obtained for experimental purposes. When tested in England on old ammoniated latex the machine gave exceptionally good results. It is not expected however that the results obtained on fresh latex will be equally good. The machine has been erected, but unforeseen circumstances prevented its being brought into service before the close of the year.

(*c*) *Concentration by Evaporation*

Reference was made in last year's report to preliminary trials with a spray drier. During the year under review, larger-scale trials have been made in London by an interested rubber Company in collaboration with the London Advisory Committee and the Rubber Growers' Association. The results obtained were instructive and encouraging.

Clone Rubber and Clone Latex

Clone Latex

During the year Dr. Wiltshire's work on variations in the composition of latex from clone and seedling rubber reached a stage suitable for publication in the form of a *Bulletin*. The broad findings were summarised by him and were delivered as part of a lecture by the writer to the Annual Conference of the Incorporated Society of Planters in September 1934. They are here recorded in their original form since they constitute his last publication :—

> "The factors influencing the composition of latex fall approximately into two groups—the controllable and the uncontrollable. In the former class may be instanced length and number of tapping cuts, time of tapping, periods of tapping and of rest and depth of tapping. All these factors, with the exception of time of tapping, are covered by the generalisation that severe tapping corresponds to

a dilute latex and light tapping to a latex of high D.R.C. Thus D.R.C. may be raised by the change from alternate-daily to third-daily tapping or by the substitution of a one-third for a one-half circumference cut. In addition to this general effect it must be remembered that, on the opening of a new cut after rest, the latex continually changes in composition over a period dependent partly on the length of the rest period. For instance, in the daily alternate-monthly system the D.R.C. drops throughout each month of tapping and in one of our experiments the D.R.C. of the first day's latex was 42 per cent while that of the last day's was only 30 per cent. If the tapping period is reasonably long the latex does reach and maintain an equilibrium composition. Thus in a system of one year's tapping after six months' rest the period of changing composition might continue for only one month or six weeks, but in a system of short-period such as the daily alternate-monthly, the latex is always changing in composition and never attains equilibrium. These facts, therefore, point to the conclusions that the tapping system should be so controlled that it yields latex of sufficiently high D.R.C. and that the periods of abnormal or changing composition should be reduced to a minimum. The ideal systems from the latter aspect are, of course, alternate or third-daily without rest periods but the question of yield per acre cannot be ignored and periodic systems will in some instances be unavoidable. The object then must be to group the tapping areas in such a manner that bulking will always include latex from areas in various phases of their tapping routine, e.g. latex from the beginning of a tapping-period should be mixed with latex from the end of a tapping period. Time of tapping does not in general vary very greatly and, while late tapping does undoubtedly result in a slight increase in D.R.C., on a well-organised estate variations due to this factor may be neglected. All the factors so far mentioned may therefore be controlled in such a way as to eliminate their powers of causing variation.

In the second group of factors will be (*a*) climate, soil and elevation (*b*) seasonal variation (*c*) strain of seed or of budwood (*d*) changes in tapping height. The last variable must be regarded as unavoidable, if not uncontrollable, owing to the necessity of carrying out the normal cycle of bark consumption and regeneration.

The effect of climate, soil and elevation is, at present, not known with any certainty and, while it must be accepted that such factors do have an effect on the composition of the latex, they can be ignored in this discussion since, on any particular estate, there is no likelihood of their changing. Seasonal changes in climate, of course, must be considered separately.

Seasonal Variation

The first example of seasonal variation in D.R.C. is found in Figure 1 (not reproduced). The curve refers to an area of seedling rubber, aged about twelve years, tapped on the alternate-daily system. The month of January is not included since the change in tapping panel at the beginning of this month causes a rise in D.R.C. which is unconnected with the seasonal variations under discussion. Each D.R.C. figure plotted is that of an average sample made up from all the tappings throughout a month and the wider day-to-day variations are thus averaged out. This system therefore corresponds to that of an estate having a bulking capacity equal to one month's crop and it will be observed that, under these conditions, the D.R.C. only varies from 30.8 to 32.8 per cent. At the defoliation stage of wintering, i.e. February and March, the D.R.C. is fairly high but it drops to minimum values during April and May while re-foliation is in progress. After the completion of the wintering phase the D.R.C. rises steadily to its maximum values during the dry months of July and August and then falls again during the wet period September to December. These changes may be regarded as fairly typical of those to be found in a mixed stand of seedling rubber.

In Figure 2 (see *Bulletin* No. 5, Fig. 11) are shown similar curves for latex from four clones, established on Pilmoor Estate, Selangor, and made available to us by the courtesy of the Directors and Manager of that Estate. The problem is complicated here by the sharp differences in physiological habit exhibited by the various clones. These clonal differences will be discussed more fully later but at present it may be noted that all clones show a similarity to the seedling rubber in the distinct fall in D.R.C. during the wet months of November and December. In the earlier months of the year the individ-

ual idiosyncrasies of the four clones mask any general tendencies.

In the work carried out during the past eighteen months it has been shown that constituents of the latex, other than rubber, also show considerable variation. Physical properties such as viscosity and specific gravity, again, vary considerably and it is probable that stability under the mechanical treatment used in compounding is also a variable. It is not proposed to discuss these constituents and properties in detail but, as an example, attention is drawn to the variable relation between D.R.C. and viscosity. In general, of course, a high D.R.C. corresponds to a high viscosity but the exact relationship between the two varies throughout the year. This variation may be seen in Figure 3 (see *Bulletin* No. 5, Fig. 30). In this figure are plotted average figures for viscosity and D.R.C. from the monthly yields of four clones. As the year progresses the viscosity curve climbs in relation to the D.R.C. and it is clear that after July a given D.R.C. is accompanied by a higher viscosity than in the earlier months of the year. For example, in January a D.R.C. of 37.1 per cent is accompanied by a viscosity of 6.9 units, while in November and December a D.R.C. of 36.9 per cent is equivalent to viscosities of 8.5 and 9.9 units respectively.

As far as is known at present these seasonal variations in latex composition are quite uncontrollable and there is no refinement of method which could be expected to eliminate them. The only possible method of minimising them is to increase the bulking capacity until it represents several single shipments of latex. Each individual shipment will then be drawn from a bulk representing the crop of several months and seasonal changes will be partially smoothed-out.

Variation due to Strain of planting Material

The collection of information on this type of variation is extremely difficult and is, at present, practically limited to the study of adjacent areas budded with single clones. Later it will be possible to apply similar methods to areas planted with clonal seeds but such areas are not yet available. Although the discussion must be restricted to clone rubber it must be remembered that different areas of ordinary seedling rubber may exhibit innate differences in

property. Every such area will give an average of the results due to many different strains but there can be no certainty that every area will give the same average.

A typical example of differences in latex composition caused by difference in strain is seen in Figure 2 (see *Bulletin* No. 5, Fig. 11). The red curve is always higher than the other three curves and it is clear that high D.R.C. is characteristic of the latex from clone B. 58. Again, the different modes of variation in the early months of the year can be attributed to characteristic clonal differences and, in particular, can be correlated with differences in wintering habit. Clones B.58 and B.84 both exhibit rapid and uniform wintering and both show a high D.R.C. in March followed by a fall in April. Clone A.44 shows a prolonged and indefinite wintering period and only small variations in D.R.C. from February to June. Clone B.16 winters only very lightly and its changes in D.R.C. show little relation to its wintering habit. It may be remarked that this particular clone is, in all respects, less definite in its relationships than the others.

Figure 4 (see *Bulletin* No. 5, Fig. 13) shows the corresponding curves for the ash or mineral content of the latex from these clones. Clone B.58 now shows a characteristically low ash content while the other three curves approximate to the same average value. The two clones which suffer sharp wintering also show very low ash values at this period, i.e. in March, and steady rises from April to June. Clone B.16, which undergoes only a very light wintering, shows practically no change in ash content during these months, while A.44, with its rather prolonged wintering period, shows a fall in ash content from March to May. The fall in July, common to all four clones, probably represents the drain in ash constituents caused by flower and seed formation.

These clonal differences may either appear therefore as constant differences in some property or the percentage of some constituent, or they may appear as differences in the response to changing seasonal conditions.

Variation due to Changes of Panel and of Tapping-height

Even in a non-periodic tapping system, changes of panel are unavoidable and are controlled by bark consumption. These changes do cause deviation from the normal latex composition but they are more transient and

less marked than those due to the re-opening of a tree after a rest period.

There must, however, always be variations in the height of the tapping panel above ground level, and differences in latex composition and properties due to these differences in height of tapping may be quite appreciable. An example is given in Figure 5 (see *Bulletin* No. 5, Fig. 3) which shows the D.R.C. of latex from two groups of trees of clone B.58. The trees of group A were tapped on a high panel throughout—actually, from a height of 40 inches. Those of group B were tapped on a low panel—eight inches downwards—for the first eight months and then changed over to a high panel corresponding with that of group A. The last four months therefore constitute a control and it will be seen that a difference in D.R.C., which persists until the change of panel, disappears immediately when group B is changed to the same panel as group A. It follows therefore that this difference in tapping height of about 32 inches causes a constant difference in D.R.C. of about four per cent—the high panel giving the higher D.R.C. Similar differences were found in viscosity, while the ash constituents showed the reverse difference, i.e. a higher ash content in the latex from the low panel.

On an ideal estate managed consistently under a "latex policy" the tapping would be so arranged that changes in tapping panel are made in rotation through the various divisions and the average tapping height over the whole estate would be kept as nearly constant as possible. In practice, on old-established estates with panels in every phase of consumption and regeneration, such a scheme will probably be regarded as unattainable perfection.

Relation between Yield and D.R.C.

The discussion of the relation between yield and D.R.C. will not give any assistance in the question of estate management but it is a point of considerable scientific interest and may give the planter food for thought.

It is a belief commonly held amongst planters that the most likely source of latex of high D.R.C. is an area of low yielding power. Accurate figures for seedling rubber do not seem to be available but that there is some truth

in the theory is beyond dispute. There is some scientific evidence in a series of observations by Grantham which disclose a small negative correlation between yield and D.R.C.

The observations made on the Pilmoor clones recently give considerable support to this theory both as regards a comparison of the various clones and as regards the behaviour of each clone over a period of one year.

The highest yielding clone is B.84 which yields on an average 45 grams per tree per tapping and gives a latex of average D.R.C. 35.7 per cent. Clone B.58 which gives the low yield of 28 grams per tree per tapping gives a latex with the high average D.R.C. of 41.4 per cent.

Similarly, in studying the behaviour of the clones throughout the year one finds a tendency for rises in yield to be accompanied by decreases in D.R.C. The best example of this is given by clone B.58 the figures for which are plotted in Figure 6 (see *Bulletin* No. 5, Fig. 20). To stress the inverse relationship, the D.R.C. is plotted "upside-down" and it will be seen that the two curves are then very similar. In March there is a minimum yield and a maximum D.R.C. while November shows the maximum yield and the minimum D.R.C. Clones A.44 and B.84 show similar relationships but clone B.16 is again somewhat anomalous in its behaviour.

The only possible conclusion is that there are certain factors which tend to give simultaneously a high yield and a low D.R.C. or the reverse. It is equally clear that both yield and D.R.C. may be affected by other independent factors which, in some instances, will destroy completely the normal relationship.

It is believed that, as latex flows from the latex vessels after their opening by the tapping knife, there is an influx of water from the surrounding cells which is responsible for the gradual fall in D.R.C. during flow. Conditions which diminish this influx of water also tend to hinder the out-flow of latex since there is a smaller decrease in viscosity. As a result the latex travels more slowly and the area of bark drawn upon for latex is smaller and a small yield is obtained. The diminished flow of water also accounts for the increased D.R.C. of the outflowing latex and thus leads to the combination of low yield and high D.R.C."

Clone Rubber

The vulcanisation properties of rubber from the Pilmoor clones have continued to be a subject of regular study during the year. A publication has been made by Dr. Wiltshire dealing with the results obtained up to and including January 1934 and this indicates that two of the four clones give rubber of which the rate of cure is appreciably faster than that of the other two. This implies that when clonal studies are extended to other and more common commercially-planted clonal material it is possible that clones may be found of which the rubber may possess vulcanising properties which differ appreciably from those of normal seedling rubber. The various clones show very similar variations in rate of cure and the variations appear to follow approximately the rainfall. After wintering however, there is a period of low tensile moduli which indicates a slower rate of cure common to all the clones, and this variation appears to be related to some factor other than rainfall. Rubber from adjacent seedling trees shows very similar variations. Results obtained since the publication of these results are very similar.

Bomb-ageing experiments have been continued on the clone rubber and also on normal plantation sheet rubber from various estates. When ageing was carried out on rubbers cured to approximately the state of maximum tensile strength in 100:10 rubber-sulphur mixes, the results were uninformative. Similarly when the state of cure was approximately two-thirds optimum, it was not possible to differentiate easily between the ageing properties of the various samples. It was at length decided to adopt temporarily a state of cure represented by the time of optimum cure, less twenty minutes. This state of cure shows easily discernible differences. The clone rubbers have been tested for four successive months by this method and there are indications that one at least of the four clones differs from the others in respect of this property. During the coming year it is hoped, by mutual arrangement, to adopt an ageing technique which will be identical in our laboratories and the laboratories of the London Advisory Committee.

Coagulants

Sulphuric Acid

During the year a report has been published upon the properties of special samples of rubber prepared by the use of this coagulant for examination by the London Advisory Committee and the India Rubber Manufacturers' Association. The report indicates

that, given care in preparation, the product obtained by the use of sulphuric acid can be of good quality. With rubber mixes containing accelerators the behaviour of the rubber is somewhat different from that of rubber prepared by the use of acetic and formic acids and, if a buyer is not aware of the nature of the coagulant which has been used in preparation, manufacturing troubles may arise. Estates have accordingly been advised not to employ sulphuric acid without declaring the fact to the purchasers of the product.

Coagulants used by Malayan Small-holders

With the inauguration of the Small-holders Advisory Service the opportunity was taken to make as complete a survey as possible of the coagulants used by the small-holders. These are usually sold in small bottles; Asiatic Rubber Instructors were instructed to obtain authentic samples of each of the many different brands sold in the districts. These have been examined and it has become apparent that, in some but by no means all districts, sulphuric acid is sold and used extensively. There is also little doubt that the use of this coagulant is of long standing. Steps are being taken to discourage this practice.

Special Coagulant Mixtures for alkaline Latex

In estate work it is occasionally necessary to coagulate batches of strongly-alkaline latex and the acids which are commonly employed for coagulation give very unsatisfactory coagulation; where centrifugal concentrate is manufactured the skim latex presents a similar problem, and where large-scale bulking of ammoniated field latex is carried out for sludge separation the separated sludge-rich fraction calls for an easy method by which it can be transformed into low-grade but saleable rubber. In laboratory experimental work the need for a coagulant which will give a smooth coagulation and a coagulum which can be rolled into sheet is still more pressing; in the course of the year coagulant mixtures of sodium silicofluoride with magnesium sulphate and chloride have been developed and used successfully by Mr. Hastings for this purpose. A paper on the subject, published in Vol. 5, No. 4 of the Institute *Journal*, gives details of the mixtures which have been employed for the coagulation of Utermark skim latex, creamed latex, ammoniated latex and fresh field latex. By the use of these mixtures many samples of rubber have been prepared in the laboratory from alkali-treated latex in the search for rubbers having modified properties.

Mould Preventatives for Sheet and Crepe Rubber

Improved manufacturing methods, coupled with the fact that few if any estates store rubber for long periods, has made the use of these substances practically non-existent during the year and no special study has been made of them in spite of the fact that paranitrophenol is by no means the ideal for the purpose. A warning has been issued against the use of this material in crepe manufacture, although so far as we are aware Malayan estates already avoid its use for this purpose.

The Preparation of Standard and Modified Rubbers

Deterioration of Sheet Rubber caused by the presence of Manganese

The long storage of a large consignment of Malayan estate rubber by an American consumer resulted in very severe softening and tackiness. On examination the rubber was found to be rich in manganese, to the presence of which the softening was attributed. The American findings were confirmed in Malaya and an enquiry into the source of the contamination was carried out on the estate. One of the estate water supplies was found to be extremely rich in manganese and experimental batches of rubber were prepared with it at the Institute against controls from manganese-free water. Tests carried out on these rubbers by the officers of the London Advisory Committee indicated beyond doubt that the manganese-rich water was the cause of the deterioration. A brief note on this incidental investigation will shortly be published.

Rubber having the Property of low Water-Absorption

Research has continued throughout the year with the object of finding if possible a simple method of producing a rubber of which the water-absorption properties would be exceptionally low and which would therefore be of special value in the electrical industries.

A thorough examination has been made of:—

(i) effect of dilution of latex

(ii) interval between addition of acid and lifting of coagulum

(iii) soaking of coagulum

(iv) variation in thickness of wet sheet, and

(v) soaking of freshly-machined (wet) sheet.

The broad conclusions which have emerged are

(a) when no soaking is practised, water-absorption is high and the rubber from same-day machining has a higher water-absorption than that from next-day machining;

(b) when a freshly-machined (wet) sheet is soaked for two hours water-absorption is much reduced. Within reasonable limits the thickness of the sheet has little effect on its water-absorption;

(c) a soaking period of two hours reduces the water-absorption of sheet machined on the day of coagulation to approximately the same level as that of sheet machined on the day following coagulation. The thickness of the sheet is again a negligible factor;

(d) long soaking for several days is only very slightly more effective than a period of a few hours;

(e) soaking the coagulum before machining has little effect on the water-absorption of the sheet prepared from it;

(f) the degree of dilution of the latex before coagulation has far less effect on the water-absorption than a short period of soaking.

The only simple operation which has any appreciable effect on the water-absorption of sheet rubber is seen therefore to be a short soaking period. These results suggest that crepe rubbers prepared from coagulum which had been machined into sheet and soaked for a few hours before being finally creped, might give a rubber of appreciably lower water-absorption. Experiments on these lines are in progress but final results are not yet available. It now seems probable that, without special pre-treatment of the latex, it will not be possible, by variations in factory technique, to reduce the water-absorption to very low values, but since soaking treatment does undoubtedly effect a decided improvement, the electrical industries might for the time being welcome rubbers so prepared. It is hoped in the near future to test the feeling of this special market by making trial shipments.

Preliminary experiments have been made with the pre-treatment of latex with the enzymes papain and bromelin in order to reduce if possible the nitrogen content of the rubber prepared from it; in a general way water-absorption appears to be directly related to nitrogen content and a pre-treatment of this nature might be expected to give a product having lower water-absorption prop-

erties. At the close of the year the results were not however very encouraging.

At the request of the London Advisory Committee and the Research Association of British Rubber Manufacturers, both of which organisations are carrying out investigations on this problem, a series of specially-prepared samples has been forwarded from the Institute. The series was prepared in such a way as to leave varying amounts of serum constituents in the final products. The results obtained in England are not yet available.

Rubber from alkaline Latex

It was observed in the laboratories of the London Advisory Committee that rubber prepared from alkaline latex readily became soft under the action of heat and a memorandum of suggestions was forwarded to the Institute for work on this subject. The work which was being conducted by Mr. Hastings on the development of coagulant mixtures for alkaline latex had already provided numerous samples of sheet rubber from alkaline latex of various kinds; the coagulant mixtures do not function by virtue of acidity and are therefore particularly suitable for work of this kind. The rubber which is obtained by their use from alkaline latex is never in the course of preparation brought to an acid condition. Further the product is sheet rubber which is necessarily subjected to a moderate degree of heat for a fairly prolonged period. Numerous samples of sheet rubber from alkaline latex have been forwarded to the laboratories of the London Advisory Committee and it is felt that these will prove of particular interest in view of their manner of preparation.

Nitrite and Copper sulphate Rubbers

Nitrite Rubber

A series of sheet rubber samples prepared from latex containing amounts of sodium nitrite up to 3.0 per cent was despatched to the laboratories of the London Advisory Committee where its usefulness in the production of soft rubber had been demonstrated. Examination revealed that the rubbers were softer than normal sheet rubber but abnormalities in other properties render them unacceptable at present as a new type of estate sheet rubber.

Copper Sulphate Rubber

For the purpose of preparing a rubber which could be easily handled by manufacturers sheet rubber samples were prepared

from latex to which copper sulphate had been added in various very small amounts. The products were found on examination to be softer than normal but the use of copper salts even in small amounts is considered to be extremely undesirable in the preparation of estate sheet rubber for manufacturing purposes.

Although these types of rubber have at present no real interest for the rubber manufacturer, they have proved of interest in certain investigations on the incorporation of rubber into paints, which are in progress under the auspices of the Technical Research and Development of New Uses Committee of the Rubber Growers' Association. In response to a request, samples of both types of rubber have been specially prepared for this work with much larger amounts of sodium nitrite and copper sulphate. Reports on their value for use in paints will not become available for some time.

Rubber for the Manufacture of odourless Articles

In last year's report reference was made to the preparation of various samples of crepe rubber for investigations which were being made in London under the auspices of the Rubber Growers' Association. A recent report indicates that the materials prepared at the Institute gave good results and it remains to be seen whether a demand will arise for estate rubbers similarly prepared.

Preparation of Sheet Rubber

Sheeting Batteries

During the year the tendency has been for manufacturers of line-ahead batteries to improve their equipment by the addition of an extra pair of smooth rolls so as to give the coagulum the equivalent of five rollings through smooth and one rolling through marking rolls. A further simple but very useful change has been made in the size of grooves on marking rolls and in the cutting of the marking rolls for imprinting estate names. In the past it has been the common practice to use $\frac{1}{8}$ inch grooves, and a wide deep central channel on the marking roll for the estate name. These grooves caused slow and imperfect draining of the wet sheet, while the deep central channel carrying the Estate name increased the drying period by at least one day owing to the extra thickness due to the depth of the lettering. The adoption of 3/32 or 1/16 inch grooving, and the substitution of a surface-printed estate name in very small shallow letters for the deep central name channel, has greatly improved the drying time and the appearance of sheet rubber on a number of estates.

It was confidently expected that this year would have seen the two new types of compact battery, to which reference has been made in two successive reports, in operation on estates. In point of fact however, the erection of the first example of one of the new types was not quite complete at the close of the year and it is again not possible to give indications as to their efficiency.

Drying and Smoking

In the earlier months of the year Mr. Bishop conducted experiments at Kepong Estate with a small steel cabinet dryer built for the Institute by the Federated Engineering Co. of Kuala Lumpur. The cabinet holds 500 lbs of rubber and is heated by hot water circulated through a pipe system from a domestic hot-water boiler. A separate smoke-box supplies smoke through suitable ducts situated in the floor of the building. Air inlet pipes are similarly situated and the intake of both air and smoke can be controlled. Adjustable roof ventilators are also fitted so that good control of heat, smoke and ventilation is possible. In this building sheet rubber of normal thickness was smoked in forty-eight hours at a temperature not exceeding 140°F. The fuel consumption figures were, however, high. Subsequently, the Federated Engineering Co. supplied a similar but larger outfit to the order of a Rubber Company. This dryer consists of two cabinets, each holding 1000 lbs of dry rubber with a drying period of 48 hours. In practice it has been found necessary to machine the rubber to a thickness not exceeding 1/10 inch if complete drying is to be achieved in 48 hours. The fuel consumption on this large model is reported to be less than one pound of fuel per pound of rubber, which is quite satisfactory. The capital cost of the building is rather high as compared with that of smoke houses of conventional types and similar size, but it may be that if this new design becomes more popular the price will be reduced.

"Socfin" dryers, heated by steam and also providing for a two day drying period, have continued to give satisfactory service on a number of estates.

The single-storey "Subur" type smoke house which consists of four cabinets supplied with smoke and heat from an ordinary furnace through an underground flue system is an efficient if more conventional type. As in the two types previously described, the rubber is brought from factory to smoke house and out again on trolleys; this is a great convenience and saves much handling. A number of "Subur" type smokehouses have recently been erected and the design has been illustrated by the Institute in a recent circular on factory equipment and lay-out. This type of building

is not very suitable for waterlogged sites, but United Engineers Ltd., Ipoh, have recently submitted to the Institute drawings of a house modified to suit such conditions. Certain changes were suggested and a design has now been evolved which on paper gives every indication of being satisfactory on high water-table sites.

Service Trials of Rubber Flooring

The service trial of rubber flooring samples by the Federated Malay States Railways at the request of the Rubber Growers' Association has continued throughout the year. Inspections have been made from time to time by Institute officers and at the last inspection surface deterioration was apparent in 37 per cent of the samples. The test will continue throughout the coming year.

Packing Experiments

A small-scale experiment was made with paper sacks and this indicated that such packages travelled well. A description of the Institute experiments together with a much more valuable one, not under the Institute's auspices, with 500 paper packages from Merlimau Pegoh Estate has been given by Mr. Moore in Vol. 5, No. 4, of the Institute *Journal*.

Advisory Work and routine Chemical Examinations

As in previous years there has been a large amount of advisory work, which has been dealt with promptly. Factory equipment and lay-out was made the subject of a circular which has been very well received by the planting community; its issue has incidentally saved a good deal of laborious correspondence. Queries concerned with latex preservation and concentration have been frequent and have brought in their train a number of samples for analysis.

Lectures and Demonstrations

Lectures as under were given to branches of the Incorporated Society of Planters:—

Lecturer	*Branch*	*Subject*
R. O. Bishop	Kuala Selangor Branch	Present methods of Rubber manufacture and packing

Lecturer	*Branch*	*Subject*
R. O. Bishop	Nilai-Labu Branch	Drying of Rubber
A. Moore	Rantau—Port Dickson Branch	Sulphur Dusting
E. Rhodes	Annual Conference of the Society	Recent Investigations on Latex

Publications

(i) BULLETIN. "Variations in the Composition of Latex from Clone and Seedling Rubber" by J. L. Wiltshire
Bulletin No. 5.

(ii) PAPERS

1. "The Causes of Discolouration in preserved Latex" by Edgar Rhodes and K. C. Sekar
R.R.I. Journal Vol. 5, No. 2.

2. "Malayan Patents relating to Rubber. Part II" by E. Rhodes and J. L. Wiltshire
R.R.I. Journal Vol. 5, No. 2.

3. "The Specific Gravity of preserved Latex" by Edgar Rhodes
R.R.I. Journal Vol. 5, No. 3.

4. "The Properties of Clone Rubber—Part II" by J. L. Wiltshire
R.R.I. Journal Vol. 5, No. 3.

5. "Rubber from Latex coagulated with Sulphuric acid" by G. Martin and W. S. Davey with
"Discussion and Recommendations on the foregoing Paper" by J. L. Wiltshire and E. Rhodes
R.R.I. Journal Vol. 5, No. 3.

6. "Rubber from dilute Latex" by G. Martin, W. S. Davey, H. C. Baker and E. Rhodes
R.R.I. Journal Vol. 5, No. 3.

7. "Rubber from autoclaved Latex" by G. Martin and Edgar Rhodes
R.R.I. Journal Vol. 5, No. 3.

8. "Note on the Incorporation of a Rubber Softener with Latex and its Effect on the Plasticity of the Rubber" by G. Martin, W. S. Davey, H. C. Baker and E. Rhodes
R.R.I. Journal Vol. 5, No. 3.

9. "Rubber from Latex-bitumen Mixtures" by G. Martin, W. S. Davey, H. C. Baker and E. Rhodes
R.R.I. Journal Vol. 5, No. 3.

10. "Preliminary Observations on the Coagulation of alkaline Latex" by J. D. Hastings
R.R.I. Journal Vol. 5, No. 4.

11. "The Packing of raw Rubber" by A. Moore
R.R.I. Journal Vol. 5, No. 4.

(iii) Abstracts, Reviews, and Lectures

1. "Recent Investigations on Latex" by Edgar Rhodes
The Planter Vol. 15, No. 11.

2. "Quebrachitol" by E. Rhodes
R.R.I. Journal Vol. 5, No. 2.

3. "Objections to the Use of Paranitrophenol in the Preparation of Crepe Rubber" by E. Rhodes
R.R.I. Journal Vol. 5, No. 3.

4. Book Review "Chimie et Technologie du Latex de Caoutchouc" by E. Rhodes
R.R.I. Journal Vol. 5, No. 4.

(iv) Information Cards

Information cards were revised and issued in new form in February, 1934.

Exhibitions

(i) Malayan Agri-Horticultural Show

The chief exhibit by the Institute at the Malayan Agri-Horticultural Show in June consisted of a complete model factory

lay-out for the preparation of sheet rubber; this was assembled by Mr. Bishop. It comprised a working model of the "F.E." battery and a model hot-water-heated cabinet dryer which were supplied by the Federated Engineering Co., Kuala Lumpur. The model bulking tanks, coagulating tanks and chutes were the work of Messrs. Diethelm & Co. Both these firms well deserved the tributes which were paid to their work.

The remainder of the exhibit was devoted to latex and its defects, and articles made direct from latex.

The exhibit as a whole attracted many interested persons and enquiries and questions were gratifyingly numerous.

(ii) Exhibition at the Imperial Science Museum, South Kensington, under the auspices of the Rubber Growers' Association

The complete model factory, numerous samples of rubber both dry and in a wet partially-manufactured condition, samples of discoloured latex, and latex constituents were despatched to London to form part of a comprehensive exhibit designed to illustrate all phases of rubber production.

Since the opening of the exhibition in October, 1934 the thanks of the Rubber Growers' Association to all concerned have been received at the Institute and it is known that the model factory has proved very attractive to visitors who far outnumber those who saw the exhibit at the Agri-Horticultural Show.

Edgar Rhodes

Senior Officer, Chemical Division

15th January, 1935

APPENDIX

Chemical Division

Number of Samples examined

Ammoniated Latex	211
Latex Preserved	9
Latex Preserved for Concentration Analysis	6
Latex Preserved for Colour Test	3
Centrifuged Latex	3
Concentrated Latex	2
Creamed Latex	15
Re-creamed Latex	1
Control Latex	1
Clarified Latex	1
Sludge Latex	3
De-sludged Latex	5
Fresh Latex	14
Field Latex for Experimental Purpose	15
Latex Serum	3
Latex Sludges	7
Latex Preservative	2
Latex Disinfectants	4
Formalin	1
Formic Acid	6
Acetic Acid	11
Hydrochloric Acid	1
Other common Estate Chemicals	27
Water	31
Creaming Agents for Latex	53
Hydrometers	157
Sheet and Crepe	129
Defective Sole Crepe	4
Compo Crepe	1
Crumb Rubber	10
Autoclaved Rubber	3
Rubber Road Block	1
Rubber Roadway on Cowling Malaytex Trials	1
Rubber Floorings	14
Rubber Chemicals	1
Rubber Rings	1
Manufactured Rubber Compound	1
Paints for Latex Containers	10

Zinc Oxide Paint for Latex Containers	1
Varnish for Latex Containers	2
Faithfull Patterned Para	11
Sodium Sulphite Solution	2
Pitches and Tars	4
Materials for Latex Containers	4
Seals for Latex Containers	1
Strips of Metal coated with Wailes Dove Bitumastic Standard Black Solution	4
Aluminium Alloys	2
Silicon Alloy Sheets	5
Seekay Wax	2
Anti-corrosive Steel	2
Metal Plates for Latex Containers	2
Stabilisers for Latex	2
Papain	2
Duprene ("Artificial Rubber")	1
Residue from Latex	1
Rabaulin (Hessian treated with Latex)	1
Latex Pulp Boards	1
Ply-wood	5
Paper Sacks	1
Manganese-deteriorated Rubber	3
Lotol (Processed Latex)	3
Dispersite (Dispersion of Raw or Reclaimed Rubber) ...	1
Sulphur	3
Spherical Particles from Crepe Rubber	1
Bitumen	2
Coagulants	105
Wire Gauze for Straining Latex	1
Fungicides	1
Total ...	944

ANNUAL REPORT

EXPERIMENT STATION

Acreage Statement

Planted	...	894.45	acres
Building Site, Roads, etc.	...	66.50	„
Elephant Belt	...	85.10	„
Reserve	...	286.45	„
Total	...	1,332.50	„

Distribution of Land

Botanical Division	...	652.45	acres
Pathology Division	...	28.00	..
Soils Division	...	214.00	„
Building Site, Roads, Elephant Belt, etc.	...	151.60	..
Total	...	1,046.05	„

Reserve Area

During the year under review discussions with the Forest Department were continued, and an exchange of land was eventually arranged. An area of approximately 989 acres of reserve, in which the soil is very similar to that of the flat areas of the Station, has been returned to the Forest Department. In exchange an area of approximately 356 acres of hilly and undulating land, adjoining Bukit Nibong Gila on the south-western side of the Station, has been acquired. The soil on this area is more suitable for our present requirements.

Arrangements have been made with the Forest Department enabling the Institute to collect normal royalty from timber contractors working this area for the Institute, since a premium for timber rights is paid on the land. A considerable sum has been collected as royalty to date, and by having the jungle thinned-out, costs for felling and clearing will be lowered.

New Plantings During 1934

Block 26.—(Planting in secondary jungle without burning)

A portion of the old elephant belt, 10.9 acres, consisting of a strip of secondary jungle two chains wide, along the south-western boundary of Blocks 19 and 24, was planted in May 1934 in the following manner.

Since the existing secondary growth, representing six years' rejuvenation of secondary jungle after felling in 1928, was required to act as a fire belt between a new clearing and established young areas, it was not possible to fell and clear in the normal way. 'Rentises' about 8 feet wide on contours at intervals of 22 feet were cleared, terraces cut and the area planted with basket plants. On completion of the burn in the adjoining new clearing (Block 27) the secondary growth between the terraces in Block 26 was cut down and piled between the planted rows. This area has not been subjected to a 'burn' at any stage.

Blocks 27, 28 and 29 (New clearings from jungle)

An area of 62.8 acres of hilly land in the new reserve was felled and prepared for planting by the following method.

Felling of the large trees was first carried out; the tops and side branches of the large trees were lopped and, wherever possible, loppings and undergrowth were piled on the trunks of the large trees in order that during the burn the surface soil should be affected as little as possible. The whole area received a light burn six weeks after the completion of felling and piling.

Contour lines were traced at 22-feet intervals and Chinese contract labourers removed all timber from the contour traces, swinging logs between the cleared contours to assist in checking soil erosion. Terraces 6 feet wide were cut along the contours and holing was done at 11-feet intervals. The terraces, owing to the nature of the soil, were cut with a 1½-ft. wide pronounced inward slope and solid 'stops' were retained at intervals of 11 feet between the planting holes. Stumps were removed along the terraces only where they interfered with planting.

Over the whole area regeneration of secondary jungle shrubs and herbaceous plants has been allowed to take place between the terraces. The leguminous cover plant *Indigofera endecaphylla* has been planted on the edges of the terraces.

Block 27

This block is being utilised conjointly by the Botanical Division

and Soils Division to carry out experimental work with the following aims:

(a) to investigate different methods of planting on hilly land utilising the natural flora for the control of soil erosion; the new methods to be compared with the older methods which involve extensive weeding and the establishment of leguminous cover plants of both shrubby and creeping species;

(b) to compare the relative values of seedlings derived from high-yielding proved clones, from monoclone and mixed clonal plantings, buddings of best-known clones, and ordinary unselected seedlings.

This experiment occupies an area of 50 acres divided into five blocks of ten acres each. Each block is sub-divided into five strips of two acres each in a north to south direction and each strip is planted with one of the five types of planting material under test. The distribution of planting material has been randomised in each of the five blocks. Further sub-division into 2-acre strips in an east to west direction has also been made and the five different methods of cultivation and maintenance are represented in each block. This arrangement will permit of accurate comparison between the various types of planting material and methods of cultivation on the basis of five plots of two acres each for any one type of material or method of cultivation.

To facilitate supervision and control during the progress of the work, plot boundaries have been permanently marked with single-strand wire fences. Each plot of two acres has an initial stand of about 400 trees. It is intended to carry out selective thinning to the point when each plot will constitute a single tapping task of convenient size. This arrangement will considerably simplify the work of recording in later years.

The plots under different cultivation treatments are sufficiently large to permit of the collection of reliable data of the actual costs of the different methods under test.

Planting was carried out in October and November with ungerminated seed at stake, four seeds per hole. Supply planting will be completed with basket plants in January 1935.

Blocks 28 and 29

Two small areas (12.8 acres) adjoining Block 27 have been prepared for planting in the same manner and will be planted with experimental material from nurseries in April 1935.

Over the whole of this new clearing the natural indigenous plants have been allowed to regenerate. It is proposed to commence selection and control treatments in early 1935, and in plots

under various mixtures of leguminous plants the natural covers will be eradicated as soon as the leguminous covers are well established. Terraces throughout will be clean-weeded except for the cover of Indigofera on the bunds and stops.

Details of costs will be given under appropriate headings but it may be of interest to record that the total cost from felling to planting, excluding the cost of the specially-selected seed employed, has been $41.00 per acre.

Blocks 1A and 16F

Two small areas, originally reserved for building and factory sites and no longer required for this purpose, have been planted for the Botanical Division with seedling stumps grown from clonal seed from isolated seed gardens. Block 1A (3 acres) contains seedlings from clones A.V.R.O.S. 157 and 49, and Prang Besar 25. Block 16F (2½ acres) contains seedlings from clone B.D.5.

Details of lining, holing and planting of the above areas are summarised below:—

Block	Area (acres)	Planting distance (feet)	Planting holes (feet)	Date of completion	Allocation
1A	3.0	20 x 20	3 x 3 x 3	May 1934	Botanical Division
16F	2.5	20 x 20	3 x 3 x 3	„	„
26	10.9	22 x 11	1½ x 1½ x 2½	„	„
27	50.0	22 x 11	1½ x 1½ x 2½	Nov. 1934	Soils Division and Botanical Division
28 & 29	12.8	22 x 11	1½ x 1½ x 2½	Not yet planted	Botanical Division
Total	79.2				

NURSERIES

As the existing multiplication nurseries are no longer adequate for our requirements, it was decided to utilise a portion of the central building reserve for a new nursery area. An area of approximately eight acres, which has been maintained under a heavy cover of *Centrosema pubescens,* was selected. Over this area the covers were turned in; three acres of nursery beds were made, and seed from seedling areas germinated and established in these

beds. The remainder of the area is to be treated as follows:—

three acres to be made into a demonstration nursery for leguminous and natural covers;

two acres to be planted with seed of leguminous shrubs for experiments on control by slashing and the provision of seed.

The old seedling nursery—Block 12 (5 acres), which has been used as a demonstration plot for budding work was eradicated, and this area will be utilised as a new experimental plot in 1935.

The collection nursery Block 4 (5 acres) will be cleaned up and converted into a new experimental block as soon as the clone collection can be transferred to the new nursery.

Manurial Treatments

Both nurseries in Blocks 1 and 4 received an application of Sterameal and Enpekay.

Block 6. This block received its annual application of cattle manure and artificial fertilisers. Tapping will start in this block in January 1935. No appreciable differences in growth are to be seen between any of the plots so far.

Block 18. All plants in this block of 70 acres received an application of ½ lb. per plant of Sterameal. Improvement in growth and colour of foliage is now noticeable.

No further manurial treatments were carried out during the year.

Soil Exhaustion Experiment

Block 23. Details of this area of 65 acres were given in last year's report.

The tapioca plots were not cropped this year, but final eradication of this catch crop will be done early in 1935. Considerable retardation of the rubber is noticeable in all plots interplanted with tapioca, and root disease (*F. lignosus*) is still prevalent.

Areas under coffee and pineapples, whilst not showing such a marked retardation as those under tapioca, are still behind the controls, which are under creeping leguminous covers.

Now that the rubber in this plot has been under catch crops for four years, it has been decided to eradicate all catch crops in 1935, and to lay down manurial trials to study methods of improvement of soils depleted of plant food by the heavy drain of such crops as tapioca.

Roads, Bridges and Paths

All roads on the flat areas are in a good state of repair; light sanding and trimming only has been necessary.

The hill road in Blocks 24 and 19 has stood up well, and only one serious break occurred when a sub-soil pipe under the road got clogged.

Inspection paths three feet wide have been cut and cleared of covers all round the Station boundary and supervision is thus facilitated.

Drainage

Two rounds of normal upkeep of the main system were completed during the year.

Three new tap drains 6ft. x 3 ft. 6 in. x 1 ft. were cut in the northern end of Block 14A. Since these drains were completed there has been a very noticeable improvement in the growth of the trees in this area.

Two sets of culverts under the roads were taken up, the drains lowered and the pipes re-set in Blocks 1 and 14A.

Considerable silting of the Sungei Payong in the jungle on the southern boundary occurred on two occasions, and it was necessary to clear the stream for a distance of about 40 chains in the jungle.

The system of anti-malarial drains was inspected monthly and it was pleasing to note that little silting-up of these drains occurred. No further anti-malarial drains were cut as the present system appears to be perfectly satisfactory.

Terracing, Silt Pitting and Bunding

Terracing. Blocks 26, 27, 28 and 29 were terraced with V-shaped terraces 6 feet in width, the back slope being cut 2ft. 6in. into the solid and the spoil thrown forward. Stops 18in. wide were retained at intervals of 11 feet along the terraces.

The cost of this work, using Tamil labour for terraces averaging 30 chains per acre, was $11.10 per acre.

Upkeep of Terraces, Block 24. Due to the density of planting in this block, and the fact that clone B.D.5 is now branching heavily, the cover plants and grasses are dying back. Slight erosion, and a few small breakages along the terraces were observed. To prevent further erosion, the fern *Nephrolepis biserrata* was established between terraces. The cost of this work, for pulling the fern in the swamp, transport and planting at 6 ft. intervals, was $1.50 per acre. Various natural covers are making their appearance and these are being retained.

In the new clearing, Block 27, slight breakage of some terraces was noticed, especially in the ravines; pineapple suckers have been planted on the edges of the terraces so affected.

Cover Plants

Blocks 7 and 8, planted in late 1928—age 6 years

These plots were originally laid down for the study of the incidence of root disease on young rubber trees under conditions of clean weeding and under various leguminous cover plants—*Calapogonium muconoides*, a creeping, shallow-rooted, herbaceous cover; *Crotalaria anagyroides*, moderately vigorous shrub cover; *Leucaena glauca* (Lamtoro), strong, deep-rooting shrub cover.

During the early years all covers were found to retard the growth of the trees, the effect being greatest in the Calapogonium plots and least in the Lamtoro plots. With increasing age of the trees and the formation of a closed canopy of foliage the cover plants have become progressively weaker. At the end of the sixth year Calapogonium has practically disappeared: the same applies to Crotalaria and only a weak growth of Lamtoro now remains.

Blocks 9 and 11, planted in 1929 January—age 6 years

These blocks were also established primarily to study the effect of heavy undergrowth of secondary jungle plants on the incidence of root disease on young rubber. The object was to reproduce the conditions frequently encountered in early years on young native holdings. At the same time observations on the growth of the trees in recent years have been of considerable value in view of the interest in the use of natural indigenous covers in rubber areas—the so-called forestry methods of cultivation. Block 9 has received normal treatment and serves as a control for Block 11. Details of the treatment of the area were given in the last annual report.

Pronounced retardation of the growth of the trees is noticeable in all plots, whether the natural undergrowth has been controlled by slashing or practically uncontrolled. The portion of this area cleared in early 1933 has shown extremely vigorous growth during the past two years and now compares well with the control clean-weeded plot. In the control plot (Block 9) over 80 per cent of the trees have reached tappable size, whilst in the *belukar* plots less than 60 per cent of the trees have reached this standard.

In 1935 it is proposed to clear strip-rentises 6 feet wide along the tree rows, in preparation for tapping in July.

The observations made in these plots have been extremely useful in planning the further experiments which have now been laid down this year in Blocks 26 and 27.

Blocks 13A and B

These areas had been previously planted for demonstration purposes with various leguminous species likely to prove of value as cover plants. Owing to the failure of many of the species to establish themselves on the open, sandy soil in this area a large proportion of the block has been virtually clean-weeded since 1929. From the beginning of 1933 weeding was abandoned except for the maintenance of clean strips 6 feet wide along the tree rows. The regeneration of natural covers is now being studied in this area. No selection is practised at present and the predominant plant so far is *Melastoma polyanthum* (Straits rhododendron).

Block 17D

This block was described in detail in the report for 1933.

The superior growth of the young rubber trees in the areas planted with shrubby leguminous plants *Tephrosia candida*, *Crotalaria* spp and *Leucaena glauca* (Lamtoro), has been well maintained. In the plots planted with creeping covers, those under *Pueraria javanica* and *Mimosa invisa* show the best development. *Centrosema pubescens* appears to have the greatest retarding effect on growth.

Shrubby covers are slashed to a height of 4 feet at intervals of six months and the clippings allowed to decay *in situ*.

Block 19

An area of nine acres in this block has been utilised for an experiment designed to compare the growth and development of buddings of clone B.D. 5 under a mixed permanent cover of *Centrosema pubescens* and grasses, periodic digging-in of the cover plants and clean weeding. Growth is most advanced in the clean-weeded plots so far.

Block 25

In the southern section of this block, planted with seedlings in 1931-32, an area of eight acres has been laid out in 16 plots on the latin square system with four different treatments, each repeated four times, to compare the following methods of cultivation. At the time of commencing the experiment the whole area was under a dense cover of Centrosema, Calapogonium and Pueraria mixed with grasses. Each plot is ½ acre.

A. Grasses and cover plants turned-in and plots clean-weeded
B. After digging-in as in A, leguminous covers and all other species except harmful weeds, allowed to regenerate

C. Treated as A and B but only *Centrosema pubescens* allowed to regenerate

D. Treated as A, planted and maintained under *Leucaena glauca.*

Measurements indicate already that growth in the plots clean-weeded or planted with Lamtoro is superior to that in the plots under heavy low covers. Lamtoro has made excellent growth and is now being slashed at intervals of six months.

Cultivation

The general system of maintaining around the bases of the trees clean circles of 8 feet in diameter in all young areas up to the end of the third year from planting was continued. The clean circles are lightly forked in one month and weeded only in the next month. This system is proving to be very satisfactory.

Block 3

The whole of the heavy cover of *Centrosema pubescens* except that on the bunds was turned in at the end of 1933. The area is now clean-weeded. The growth of the trees has shown great improvement during the past year.

Block 19

Observations on the rate of erosion on a hilly area planted with a number of different leguminous cover plants have been continued. Measurements are taken periodically and forwarded to the Soils Division. *Pueraria javanica* continues to hold first place as a deterrent of soil movement in this experiment.

Pests and Diseases

Considerable trouble from grasshoppers was experienced on young budded stumps, but the use of bamboo shields helped to keep these pests in check. Attacks from the Red Spider mentioned in last year's report were again noticed, but the attacks were much lighter than on previous occasions.

Termites

During the year a monthly round of inspection on all blocks was made, against the ravages of termites. This patrol has proved most satisfactory, losses for the year being only 6.5 per cent of the trees treated.

Various chemicals are being tested experimentally, but the standard treatment over the rest of the area is as follows:—

An area of 2-ft. radius round the affected tree is opened up to about 18 in. depth. The subterranean channels are traced and Cyanamag powder is dusted over the earth taken out of the hole and down the channels. The hole is left open for four weeks. The following month the affected tree is again examined and, if no sign of termites is seen the hole and the earth to be put back is dusted with sodium silicofluoride, and the hole filled. Perimeter trees round this tree are also dusted round their bases with this powder.

Root Disease

Attacks from *Fomes lignosus, Ganoderma pseudoferreum* and *Fomes noxius* are still found and treatment continues similar to that mentioned in the 1933 report. Here again considerable success has to be reported, recorded losses being less than 5.8 per cent of the affected trees.

It may be worth mentioning that since the labourers have realised that application of copper sulphate alone is no good, and that complete removal of the mycelium must first be carefully done, successes have been greater. In the early stages of treatment, this point was not sufficiently emphasised, and consequently supposed new infections reported were more often re-attacks due to failure to remove completely all mycelium.

Pink Disease

Sporadic cases of Pink Disease are noted, and these are treated with the recommended mixture of Asphaltum and kerosene and 20 per cent solution of Brunolinum.

Oidium Heveae

One or two trees were lightly attacked by this disease, but the disease did not spread and the trees soon recovered.

Recording Instruments and Measurements

The barograph and the automatic rain gauge functioned satisfactorily and charts from these instruments were sent to the Soils Division for recording.

Isolated Seed Gardens

Jungle plots A and B—10 acres

In these two plots bi-monthly weeding is done, along the 6 ft. rubber rows between the *belukar* strips. The *belukar* itself is cut

down to 3 ft. every three months. Good growth of the rubber is observed in both plots. Attacks from termites have caused some trouble, but a monthly round of inspection and treatment helps to keep this pest under control. Little root disease has appeared so far, which corresponds with observations made in the *belukar* plot—Block 11, where no disease was recorded for the first three years.

Weeding

The system of weeding mentioned in the 1933 report has been continued with satisfactory results. Areas of young rubber, 1-3 years old, in which only 3 ft. diameter circles round each tree were kept clear of covers and in which considerable retardation of growth took place have, under the new treatment, come away well. Good growth and foliage can be seen in all plots treated on the alternate-monthly forking and *tajak* (light hoe) weeding system.

The average cost of 28.3 cents per acre per month for the whole Station for the year may be considered satisfactory, when the various types of work done are taken into consideration.

The system of 8-ft. circles round each tree will be extended during 1935 to Blocks 19 to 24, where a heavy growth of *Nephrolepis biserrata* is to be found in the low-lying areas.

No heavy work on the eradication of lalang was entailed, sporadic shoots being removed by the weeders on their monthly rounds. Upkeep of the elephant belt and the new clearings is now normal.

The main building site and drain edges are slashed monthly.

Budding

In Blocks 2, 5, 14 A & B, 14 C & D, 21, 24 and the jungle Plots A & B, all failures and supply stumps were budded with the original clones.

In Block 22, which is planted with twin seedlings, the following buddings were made on one plant of each twin:

5 rows budded with B.84
5 „ „ „ P.B.186
5 „ „ „ A.V.R.O.S.50

Upkeep pruning and snagging was carried out on all large stocks.

Various wound-dressing treatments are being tested by the Botanical Division on snag surfaces of buddings made on 3-years old stocks in Block 20. No further changes in budding technique or materials used have been made during the year.

Tapping

Test tapping. Test tapping experiments have been carried out by the Botanical Division in Blocks 2 and 4 on seedling trees. Interesting data have been obtained, and high yields are recorded on some of the seedling crosses in Block 4. Details of this work will be found in the report of the Botanical Division.

An experiment to investigate the effect of different rates of bark consumption on yield has been carried out on a small area in Block 13.

Medical and Health

Health conditions remain excellent. The following is a list of hospital cases:

Fever	1 case
Maternity	5 cases
Wounds etc	6 „
Total cases	12

Brush-oiling was again carried out over the whole opened area. The Visiting Medical Officer was satisfied with the methods employed. An improved apparatus has been designed and is in use.

A considerable saving in cost on oil and labour has been made. The expenditure for the year was $307.35 or 29.3 cents per acre which includes upkeep of the anti-malarial system over the whole Station. Since the rainfall was not below normal, the reduction of expenditure was not due to a smaller amount of rainwater in the drains, etc.

Rainfall

The recorded rainfall for the year was 104.8 inches; a noticeable feature was the small amount (3.52 inches) of rain in December.

Buildings and Machinery

All buildings are in good repair. Monthly inspections are made against damage from termites.

The electric installation was inspected by officers of the Government Electric Department, when damage had occurred in the power house, after lightning storms. On their advice and with their assistance, several changes in the system were made, and since then the installation has functioned satisfactorily. Thanks

are due to the Director and other officers of the Electrical Department.

Since it is proposed to start tapping on 1st January, 1935, over an area of approximately 110 acres, a temporary factory was made up in an old store. Hand machines were installed, and this equipment will be sufficient to carry on with, until a large factory is erected. Designs are being prepared for this factory and for a drying room and packing room.

Staff

The staff resident on the Station during the year was as follows:—

Manager
1 Clerk
1 Field Conductor
1 Laboratory Assistant for Pest and Disease work } from the Institute staff
1 Laboratory Assistant for Budding and Test Tapping } from the Institute staff

Correspondence

A considerable increase in correspondence has had to be dealt with this year. Two lectures were given before the Kuala Lumpur and Klang branches of The Incorporated Society of Planters.

Details of correspondence are as follows:—

Estimates for clearing, planting and digging in covers, etc.	...	8
Cover plants (planting distance and treatment)	...	49
Manuring costs	...	10
Details of terracing and drainage etc.	...	29
Total	...	96 letters

Cost Cards

The cost cards kept in the Station Office continue to serve a useful purpose, and many details are taken by visitors.

The History File is kept to-date, and is available for the use of visitors.

General

During the year under review 250 visitors have been taken round the Station.

Visits were also made by the Rubber Instructors of the Institute, before they proceeded to their districts. Details of field experiments were explained to them and several lectures were given.

The Health Officer, Inland Districts, Selangor, has brought a number of Medical Officers round the Station, amongst them being the Directors of Anti-Malarial Research from Saigon and Netherlands India. Methods of prevention were demonstrated, and costs of various systems of prevention work were supplied.

Mr. D. S. Gardner paid his last official visit as Visiting Agent in January, and since that date the services of a visiting agent have not been employed. I take this opportunity of thanking Mr. Gardner for his help and advice during the past five years. The central line site lay-out so favourably commented on by all visitors remains a testimony to his skilful planning of the Station, as its first manager.

The work of the Asiatic staff on the Station is noted with appreciation. Due to the large number of calls on my time made by visitors, considerable responsibility has fallen on their shoulders and they have all carried out their duties successfully.

I wish also to thank the Research Officers co-operating with me on the Station, for their assistance during the year.

H. W. Foston
Manager

10th February, 1935

ANNUAL REPORT

LONDON ADVISORY COMMITTEE FOR RUBBER RESEARCH (CEYLON AND MALAYA)

The Committee and Technical Sub-Committee each held four meetings during the year.

Membership of the Committee

Sir Harry Lindsay, K.C.I.E., C.B.E. was appointed Director of the Imperial Institute on the retirement of Lieutenant-General Sir William Furse, K.C.B., D.S.O., on the 1st October, 1934.

Meetings of the Committee and Technical Sub-Committee were attended by Dr. H. A. Tempany, C.B.E., member of the Board, Rubber Research Institute, Malaya.

Visits to the Imperial Institute were paid by Messrs. W. Whitelaw and C. E. A. Dias, members of the Board of Management, Ceylon Rubber Research Scheme.

Mr. M. W. Philpott, who was selected for the vacant post of Chemist in Ceylon, worked in the London laboratories for a short period before taking up his appointment in Ceylon.

Finance

The expenditure incurred in connection with the work in London during the year amounted to £3,025. 2. 7. After allowing for reserve for plant and for liabilities outstanding, there was an unexpended balance in London at 31st December, 1934, of £375. There were also at that date balances of £193. 3. 0. held on behalf of the Rubber Research Institute of Malaya and of £411. 11. 4. held on behalf of the Ceylon Rubber Research Scheme from the funds supplied by them to meet expenditure incurred on their behalf.

During the year the Boards of the Rubber Research Scheme, Ceylon, and the Rubber Research Institute, Malaya, agreed to the proposal of the Committee that, in order to allow time for the preparation and consideration of a revised scheme for work in London, they should continue until the 31st December, 1935, the arrangement which has been in operation since the 1st January, 1932, under which they meet in equal proportions the cost of maintaining the rubber laboratories at the Imperial Institute (namely £2,800 per annum).

Rubber Roadway Investigations

The Committee were consulted by the Rubber Research Institute, Malaya, as to (1) the desirability of continuing in Malaya the rubber roadway investigations which had been in abeyance since May 1933 owing to lack of staff and (2) as to whether the Institute could collaborate and assist in investigations or trials in England.

The Committee were of the opinion that practical experience had shown that considerable work on fundamental problems is necessary before proceeding further with technical trials with latex mixtures, and that this fundamental work could best be undertaken in Europe where better facilities are available than in the East. In the circumstances they suggested that work in Malaya should be postponed until some practical results have been established from the investigations carried out in this country and that an officer should be appointed to carry out in the Committee's laboratories a systematic study from the rubber standpoint of the preparation and properties of latex mixtures for roadways where he would be in close touch with the road experts employed by the Rubber Growers' Association and other investigators of highway construction problems. If later developments showed it to be desirable, arrangements would then be made for this officer to proceed to the Rubber Research Institute with a view to studying the possibility of developing under local conditions any promising proposals arising out of the fundamental work, and for this purpose the experience gained and the contacts established in London should be of great value in Malaya.

At the close of the year information was received that the Board of the Rubber Research Institute had adopted the suggestion in principle and were in communication with the Government of the Federated Malay States regarding the allocation of the funds necessary to provide for the laboratory research in England for a period of three years.

Research Programmes

At the request of the Rubber Research Institute observations were furnished on the Programme of Work for 1934 of the Botanical, Chemical, Pathological and Soils Divisions of the Institute. In this connection useful assistance was rendered by the former heads of the Soils and Pathological Divisions who attended the meeting of the Sub-Committee dealing with the matter, and were able to furnish detailed information regarding the objects in view.

The Committee noted with satisfaction that the Board of the Institute are in general agreement with the views they expressed, and that priority is being given to the investigations which they consider to be of major importance.

Investigations

The work consists chiefly of investigations of the physical and chemical properties of raw and vulcanised rubber after its arrival in Europe with the object of determining the cause of variability of different forms of plantation rubber and of devising methods for the production of types of rubber desired by manufacturers. The main objective is thus improvement of quality but there is no clear line of demarcation between investigations on this subject, utilisation problems and the development of new uses. As the disparity between supplies of raw rubber and demand has developed, the programme has been given a definite bias in favour of immediate practical problems connected with utilisation and, in recent years, grants have been received from the Technical Research and Development of New Uses Committee of the Rubber Growers' Association to enable attention to be concentrated on the detailed examination of a few of the ideas which have shown definite promise in the preliminary experiments.

In developing new types of rubber or latex such as crumb rubber, soft rubber and latex concentrates in connection with the work on quality, it has been necessary not only to examine the properties of the product but to explore likely outlets for its use in rubber manufacturing and in many other industries and also to supply technical advice to possible users based on the results of the experimental work. For instance, development of the use of rubber crumb has necessitated continuous contact with the technical staff of a manufacturer of road material who has been conducting practical tests with this rubber. This contact is being continued in the trials which are now being conducted.

The introduction of latex as a commercial product and the rapid increase in its use which has taken place during the last few years has brought into prominence a number of important technical problems requiring urgent attention. Although the trade is in its infancy, latex is being used for a variety of purposes outside the rubber manufacturing industry and extensive enquiries have been made from time to time with a view to obtaining information as to the properties desired by users with very varied requirements. During the year most of the work on latex was concerned with problems relating to concentration and to the development

of standardised methods of testing. There is, however a considerable field of work needing immediate attention in order to ensure the regular supply of a reliable material to which only a very limited time can be devoted by the staff at present available.

As in previous years, the staff in London co-operated with the chemists in the East in the examination of samples prepared in connection with experiments in Ceylon and Malaya. A list of the reports furnished on these investigations and on others initiated in the Committee's laboratories is given below. Further information as to the investigations completed and in progress during 1934 will be found in the technical appendix to this report.

REPORTS ON INVESTIGATIONS FORWARDED TO CEYLON AND MALAYA DURING 1934

Investigations connected with the study of methods of preparing a Soft Rubber suitable for manufacturing purposes

(1) Effect of autoclaving latex (2 reports)
(2) Effect of adding Plastogen to latex
(3) Effect of heating latex with alkaline bleaching powder
(4) Effect of treating latex with a mixture of sodium nitrite and bisulphite (2 reports)
(5) Effect of adding alkali to latex before coagulation.
(6) Effect of coagulating fresh latex with papain
(7) Effect of adding copper sulphate to latex before coagulation.

Experiments with a view to improving the plastic properties of Crepe and Sheet

(1) Effect of treating creped coagulum with hot water
(2) Effect of treating sheeted coagulum with hot water.

Clone Rubber

(1) Rubber from three Ceylon clones
(2) Rubber from a series of clones in Sumatra.

Water Absorption Experiments

Reports on two series of samples prepared with a view to reducing the amount of water absorbed by rubber from a damp atmosphere.

Investigations arising out of questions raised by Manufacturers

(1) Effect of colour of smoked sheet on plasticity
(2) Methods of packing rubber
(3) Rubber contaminated with manganese.

Special forms of Rubber

(1) "Patterned Para" (sheet prepared without machining)
(2) Rubber prepared with proprietary coagulant
(3) Crepe vulcanised at atmospheric temperature.

Creaming of Latex

(1) Creaming power of different commercial grades of gum tragacanth
(2) Value of gum and gelatine as creaming agents
(3) Latex creamed with tragon seed gum
(4) Latex creamed with methyl cellulose.
(5) Variations in the creaming power of different latices.

Utilisation of Skim from Concentrated Latex

(1) The use of magnesium chloride—sodium silicofluoride mixture as a coagulant
(2) Coagulation of latex skim with papain.

Recent Developments in the Plantation Industry of Interest to Manufacturers

Paper read by Mr. Martin at a meeting of the Manchester and District Section of the Institution of the Rubber Industry held on the 19th March, 1934.

Co-operation with Ceylon Rubber Research Scheme and Rubber Research Institute of Malaya

In addition to supplying reports on investigations, advice was furnished to Ceylon and Malaya on a variety of technical subjects. Numerous requests were also received in connection with the purchase of apparatus and equipment, staffing, etc. The Committee are glad to observe from the marked increase in correspondence that full advantage is being taken of the facilities available in London.

The Committee also followed with interest the work in the East and gave close and careful attention to the reports from

Ceylon and Malaya which were submitted for the information of its members.

The Committee were glad to observe that the staffs of both the Rubber Research Institute, Malaya, and the Rubber Research Scheme, Ceylon, are investigating the quality of rubber from budded clones which may be determined by a number of factors, the effect of which is not yet known. They noted with concern the developments in the spread of Oidium and the serious effect which the disease is having on the yield of latex in Ceylon, and in this connection they suggested that attention should be directed to the development of clones which show resistance or immunity to the disease.

In view of the difficulties in the control of Oidium by sulphur-dusting owing to the unsatisfactory character of the material supplied to Ceylon and Malaya, information was furnished by the Committee regarding the types of sulphur used elsewhere for similar purposes, and samples of products which appeared likely to be suitable were forwarded for trial.

PATENTS

Abstracts of English patent specifications in respect of inventions relating to processes for the preparation and/or utilisation of raw rubber and latex were made for the information of the Rubber Growers' Association, the Rubber Research Scheme, Ceylon, and the Rubber Research Institute, Malaya, and attention was drawn to claims which appeared to lack novelty and to cases where the grant of a patent would be likely to be prejudicial to the interests of the rubber-growing industry.

In conjunction with the Rubber Producers' Research Association steps were taken to obtain English patents in connection with inventions arising out of the work of the staff in London. Specifications were also prepared on behalf of the Rubber Research Institute in connection with investigations of the staff in Malaya.

Applications sealed during 1934

410,875. Method for the preparation of granular rubber by the mechanical treatment of wet coagulum.

Complete applications accepted during 1934 and awaiting sealing

835/34. A process for obtaining homogeneous dispersions of unvulcanised rubber in tar which previously could not be obtained.

35277/33. A process for the preparation of soft rubber on the plantation without heating the rubber to a very high temperature.

Provisional applications filed during 1934.

422/34. Improvements in and relating to the concentration of latex.

5411/34. Improvements in and relating to the treatment of latex (communicated by the Rubber Research Institute, Malaya).

7784/34. Improvements in and relating to the concentration of latex (communicated by the Rubber Research Institute, Malaya).

17070/34. Improvements in and relating to the concentration of latex.

34835/34. Improvements in and relating to the concentration of latex.

Provisional Specification prepared during 1934 and filed subsequently by Patent Agents

1275/35. Improvements in and relating to the concentration of latex.

Co-operation with Rubber Growers' Association Technical Research Committee

Close contact was mantained with the Technical Research and Development of New Uses Committee of the Rubber Growers' Association throughout the year.

In addition to the work on crumb rubber and on the concentration of latex undertaken on behalf of and at the expense of that Committee, frequent consultations were held with their liaison officer, and advice furnished on several matters arising out of the technical work being carried out by the Rubber Growers' Association in conjunction with other investigators. At the request of the liaison officer a memorandum was submitted setting out in detail particulars of scientific and technical researches recommended for inclusion in a programme of work for the development of new uses for rubber and latex.

In connection with the work which the Technical Research Committee is conducting in conjunction with the Wool Research Association facilities were granted to a member of the staff of the Association to work in the Committee's laboratories with a view to gaining experience in the properties of different types of latex.

Co-operation with other Organisations

Mr. G. Martin was a member of the Committee appointed by the Rubber Growers' Association to consider the details of

the Rubber Exhibition at the Science Museum and also of the Sub Committee dealing with the exhibit of plantation products. A number of samples illustrating the effect of vulcanisation and of ageing on the properties of rubber was prepared for the scientific section of the Exhibition. At the request of the Association a member of the staff assisted on several occasions in the practical demonstrations to the public of factory processes.

Mr. Martin continued to serve as a representative of the Research Association of British Rubber Manufacturers on the Joint Committee of that Association and the British Electrical Research Association dealing with the quality of ebonite. Technical trials are now being carried out by the Research Associations with samples prepared in Malaya by the Rubber Research Institute.

At the request of the Research Association of British Rubber Manufacturers, the technical staff examined and commented on the sections on raw rubber in the Handbook of Physical Constants which that Association is undertaking on behalf of the Rubber Growers' Association.

Both the Research Association of British Rubber Manufacturers and the India Rubber Manufacturers' Association co-operated with the Committee in an enquiry as to the colour of sheet preferred by manufacturers.

P. J. Burgess
Chairman

J. A. Nelson
Secretary

Imperial Institute,
South Kensington, S.W. 7
21st February, 1935

TECHNICAL APPENDIX

TO THE ANNUAL REPORT OF THE

LONDON ADVISORY COMMITTEE

Latex

SPECIFICATION

At intervals during the year investigations were carried out to devise methods of testing various properties of latex with a view to providing data on which the trade associations concerned can prepare a specification to ensure that only material of reliable quality will be marketed. The technical problems involved were discussed with latex technologists as opportunity occurred, and it is proposed to arrange a technical conference to consider those tests concerning the importance of which there is likely to be general agreement and for which methods are available, viz. (1) Dry rubber content, (2) Total solids, (3) Alkalinity (quantity and nature of alkali), (4) Colour of latex, (5) Colour of dry film and (6) Putrefaction.

By the end of the year sufficient experience had not been gained to enable recommendations to be made as to satisfactory colour tests for latex and for dry film, but two methods which appeared definitely promising were under investigation. A few tests on the determination of colour of latex were carried out measuring the electric current developed in a photo-electric cell. The method appeared promising, but the type of apparatus used was not suitable and further experiments with a different type are proposed. The apparatus is probably too expensive however for general use.

The putrefaction test suggested involves the detection of odour in latex coagulated with an acid such as sulphuric. As the results may vary according to the susceptibility of the operator attempts were made to devise a chemical test depending upon an estimation of certain fatty acids and protein compounds which would be expected to be present in abnormal quantities in putrefied latex. The preliminary experiments showed that, in order to obtain reliable information, prolonged and detailed study would be necessary, to which the limited staff available could not devote adequate attention at the present time. The problem is however one requiring urgent attention either in London or in the East as soon as an opportunity can be found.

It is considered that more experience is required with regard to film-strength tests and various tests for stability, and in order to obtain data which will enable technologists to assess the merits of these tests suggestions have been made for the preparation in the East of a series of samples differing in stability.

In the report for 1933 reference was made to the work carried out in the London laboratories on the film-strength tests. During 1934 special attention was devoted to stability tests and an investigation was carried out to compare the following methods:—(1) Stirring in the presence of zinc oxide, (2) Sieving, (3) Rate of coagulation with sodium silicofluoride, (4) Amount of aluminous cement required to cause coagulation. On the whole the results placed the samples examined in the same order as regards stability but there were a number of important discrepancies which require further study before any one of the tests can be recommended for a trade specification.

Concentration

A considerable amount of time was devoted to developing and carrying out trials with four different methods of concentrating latex but, as several patent applications are pending, publication of further details is not desirable at this stage.

In the report for 1933 reference was made to variation in the creaming power of a wide range of samples of gum tragacanth and as a result of the tests in London it was suggested that some of the cheaper grades of this material might be used in the East. Investigations subsequently carried out by the Rubber Research Institute, Malaya, with portions of the samples referred to showed however that the results of tests on fresh latex were different from those on latex which had been preserved for some time and that the cheaper grades of gum tragacanth which gave good results in London were not so effective in Malaya.

Considerable variation was observed in the creaming power of different latices in the presence of some of the usual creaming agents. A few tests were carried out to determine whether there be a relation between rate of creaming and physical properties of latex such as stability and surface tension, but insufficient data were obtained to arrive at a definite conclusion. A corresponding investigation showed that in some circumstances a "poor creaming" latex could be rendered "good creaming" by preliminary dialysis to remove crystalloids. The addition of an aqueous extract of serum substances sometimes decreased markedly the ease of creaming of the dialysed latex. These experiments are of considerable interest as they provide fundamental information

concerning the cause of variation in creaming and they will be continued as opportunity occurs in 1935.

Latices concentrated by two creaming methods devised by the Rubber Research Institute, Malaya, were examined. One method was designed to prevent "after creaming" and the latex showed no signs of this defect on arrival in London. One dealer in latex reported that the latex might be unsuitable for transparent articles owing to a yellow tint in the dry film, but tests in the Committee's laboratories indicated that the latex was of satisfactory colour and quality.

The other sample was prepared to yield rubber which on vulcanisation would be more resistant than usual to oil. Tests in London showed that this effect was not achieved and that the latex had other defects which would render it unsuitable for general use.

Rubber Crumb

Consignments of nitrite crumb prepared according to one of the processes devised by the staff of the Committee and referred to in previous reports (E.P. No. 395,775) were sold for use in the manufacture of white lines for roadways in England. This crumb was prepared by the staff of the Rubber Research Scheme, Ceylon, who are studying the mechanical problems arising from the large-scale production of rubber by this method. On arrival in London the crumb is somewhat massed, but is still in a granular condition and can be crumbed again by rubbing. As it is desirable that the crumb should arrive with the grains in a free condition, experiments were carried out in London to determine the effect of surface lubricants on massing. As the results were not promising the problem was discussed with the manufacturers of the white line material referred to above, who agree that re-disintegration could be undertaken by the user without undue difficulty if it is found impossible or uneconomical to prevent massing during transit. The production of white lines by this process is still in the experimental stage, but it is understood that the results so far obtained are satisfactory.

Owing to the ease with which this type of crumb can be dissolved in organic solvents, it offers advantages over crepe and sheet for incorporation with asphalt for road surfacing. In co-operation with a firm interested in the production of asphaltic road mixtures a process devised for the preparation of homogeneous mixtures of rubber and asphalt was tried by the firm on a small section of private roadway. The process appeared to be practical and arrangements were made to lay a stretch of public

highway with the material early in 1935. At present the rubber-asphalt mixtures for the highway trial are being prepared in the Committee's laboratories.

Types of Rubber required by Manufacturers

Soft Rubber

In view of the difficulties experienced by manufacturers in the manipulation of estate crepe and sheet, a detailed examination of the possibility of devising an economical method of preparing a much softer material of satisfactory quality was continued. Although some promising results were obtained, no method of preparation so far tried is sufficiently free from complications to warrant large-scale trials.

Three fundamentally different methods of softening rubber have been tried, viz. (1) Addition of rubber softeners to latex, (2) Chemical reaction including oxidation, (3) Heat in the absence of oxygen. Th experiments referred to in the Report for 1933 showed that method (1) was not likely to produce a sufficiently soft product and attention was therefore given to the other two methods.

It was found that a modification of the oxidation method gave promising results in London in experiments with ammonia-preserved latex. Samples have since been prepared in Ceylon and Malaya from fresh latex by the method suggested, but tests in London showed that the bulk of the rubber was not nearly as soft as expected although the samples softened easily on heating at 100°C. Two of the samples received from Malaya however were as soft as required. The cause of this variation is not known and it is evident that the method of preparation requires further study.

Some soft rubbers with excellent vulcanising and ageing properties were received from the Rubber Research Institute, Malaya, in connection with their study of the coagulation of skim obtained during the centrifugal concentration of latex. Subsequent experiments with latex from another estate and using a different centrifuge gave rubber which was as hard as estate sheet or crepe. There is no direct evidence as to the reason for the marked variation in hardness of rubber from different latex skims, and, as in the case of the investigations referred to in the previous paragraph, the matter is one which requires further study.

Further studies have been made of rubber softened by the addition of sodium nitrite to latex prior to coagulation and

rolling to crepe or sheet. Experiments in London with preserved latex showed that sodium bisulphite restrained the action of the sodium nitrite, and soft samples with satisfactory vulcanising and ageing properties could be obtained with suitable proportions of sodium bisulphite and sodium nitrite. Samples were also prepared in Ceylon and it was eventually concluded that the sodium bisulphite did not produce any effect which could not be obtained by the addition of smaller amounts of sodium nitrite without bisulphite. The sodium nitrite method of softening rubber has a number of objections, the chief of which is that for the same degree of softening the vulcanising and ageing properties of the rubber are adversely affected to a greater extent than in the case of rubber softened by oxidation.

An interesting type of soft rubber prepared according to the third method referred to above was received from Malaya. This consisted of crepe obtained from latex coagulated by heating for some time in steam at about 148°C. The first samples examined were not as soft as is considered desirable, but subsequent samples in which the latex was frothed and then heated for longer periods were almost sufficiently soft to obviate mastication. These samples may owe their softness partially to oxidation but they gave much better results on ageing in a rubber-sulphur mixing than rubber softened by heating in air. Definite conclusions cannot be drawn owing to a small difference in the softness of the two types of rubber. The results indicate however that a comparison should be made between the quality of rubber softened in steam and that of rubber softened by heating in air.

Arising out of a paper by the writer on the Marketing of Rubber read before the Institution of the Rubber Industry, information was received from a firm of manufacturers in Great Britain concerning difficulties experienced in obtaining regular supplies of dark smoked sheet. The pale product, which they stated formed a large part of the sheet rubber they received through London brokers direct from the East, caused considerable trouble in processing owing to hardness, and regular supplies of dark sheet could not be obtained at the standard market price. It was confirmed in the laboratories of the Committee by an examination of samples submitted that the light sheet was less plastic than dark, and the results agreed with the results of experiments carried out several years ago with a wide range of estate samples from Ceylon.

An enquiry was made through the India Rubber Manufacturers Association and the Research Association of British Rubber Manufacturers concerning the type of sheet preferred by their

members, and there was considerable difference in the views expressed. The matter was submitted to the Rubber Trade Association who replied that heavily- and lightly-smoked sheet would not be accepted by the Standard Qualities Committee.

The firm who initiated the enquiry subsequently reported that they had been successful in obtaining regular supplies of heavily-smoked sheet.

Water Absorption

In view of the demand from the electrical and other industries for rubber with a low water-absorption, various methods of preparing this type of rubber are being studied in Malaya. The results of the examination of samples received from the Rubber Research Institute indicated that the soaking of the machined coagulum in water reduced the tendency of rubber to absorb water from a damp atmosphere by an amount depending upon the period of soaking. Dilution of the latex before coagulation and machining of the coagulum are not important if the machined coagulum is soaked for a short period. Samples of sheet rubber which absorbed less than half the amount of water absorbed by average estate sheet were forwarded at their request to the Research Association of British Rubber Manufacturers for technical trials. The results so far obtained suggest other lines of work which may lead to the production of a material with even less tendency to absorb water than that already obtained.

Miscellaneous Types Of Rubber

Rubber containing Manganese

A rubber manufacturer found that a consignment of raw rubber perished badly after storing for two years and the deterioration was eventually traced to the presence of manganese. The problem was referred to the Rubber Research Institute, Malaya, who carried out experiments on the estate on which the rubber had been prepared and found that one of the water supplies of the estate was contaminated with manganese. On examination in London samples prepared using the contaminated water and Rubber Research Institute water known to be free from manganese were equal in appearance to first grade rubber, but that made from the manganese-contaminated water quickly became soft on heating in air and perished quickly in an artificial ageing test on the vulcanised material. The harmful effect of manganese on rubber is well known, but it was not previously established that rubber containing manganese could easily be

classed as first grade and that ageing tests were necessary to show that the rubber was inferior. According to the Rubber Research Institute the possibility of water supplies being contaminated with manganese is remote, and the estate with the contaminated water supply has not used this source of water for some time and is not likely to use it again.

Patterned Para

Several samples of smoked sheet prepared by a patented process which eliminates the machining of the coagulum were examined during the year. The appearance of the rubber was not quite as good as that of standard sheet, but probably could be improved by attention to detail.

The properties of the rubber were in accord with the retention of more serum substances than usually occur in sheet, and apart from this effect there was no evidence that the absence of machining had modified the properties of the sheet. The rubber is not of great technical interest, but it might secure a market, depending upon the special requirements of a few manufacturers.

Clone Rubber

The examination of samples of rubber from different clones in Ceylon was continued, three clones being now under test as compared with two last year when, as the trees were young, no conclusions were drawn concerning the quality of the rubber. Further results are in agreement with those obtained previously and indicate that there is a considerable difference in the quality of the rubber, two of the clones yielding material which is distinctly superior to the third.

There are many unsolved problems connected with the quality of clonal rubber in the East and little of the information so far obtained by various investigators has been published. Subsequent tests may prove that quality of rubber is not an hereditary characteristic, that agricultural, climatic, and other factors have a considerable effect, and that the inferior rubber can be rendered satisfactory by adjustments in preparation or in manufacturing practice, but it is obviously undesirable that clones yielding inferior rubber in preliminary tests should be planted extensively until it has been shown that there is no risk of producing on a large scale rubber which is unsuitable for the manufacture of high-grade articles without special treatment.

Packing

Three different consignments of smoked sheet were examined during the year in connection with experiments on the packing of

rubber. Two were small-scale experiments organised by the Rubber Research Institute, Malaya, to obtain information concerning the suitability of paper containers and different types of baling material. The other was a large-scale experiment organised by a member of the Rubber Growers' Association interested in paper sacks. A few of the sacks were torn on arrival in London and, in some, paper adhered to the rubber, but the condition of the bulk of the rubber indicated that paper sacks were promising containers for rubber owing to cleanliness, cheapness and ease of handling.

Rubber packed in paper sacks may satisfy many of the large manufacturers, but it would be necessary to dust individual sheets to facilitate handling at the wharves and by small manufacturers. The dusting of individual sheets with a surface lubricant markedly improved the ease of separation of the individual sheets in each bale.

Of the other materials tried *menkuang* matting was found to be cleaner than gunny or hessian, which left fibrous material adhering to the rubber.

It is not possible to make definite recommendations as regards packing because the requirements of different sections of the trade are not the same and complicated marketing problems are involved. Individual estates should proceed cautiously and consult the various interests involved before making radical changes in their method of packing.

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